Vol. III

TRANSCRIPT OF RECORD

(Pages 1023 to 1504)

Supreme Court of the United States

OCTOBER TERM, 1943

No. 392

UNIVERSAL OIL PRODUCTS COMPANY,
PETITIONER,

vs.

GLOBE OIL & REFINING COMPANY

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT

PETITION FOR CERTIORARI FILED SEPTEMBER 28, 1943.

CERTIORARI GRANTED NOVEMBER 15, 1943.

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IN THE

Supreme Court of the United States

OCTOBER TERM, A. D. 1942.

No. 2032

UNIVERSAL OIL PRODUCTS COMPANY,
Petitioner,

vs.

GLOBE OIL & REFINING COMPANY,
Respondent.

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT.

THE BUNTHORP-WARREN PRINTING COMPANY, 310 WEST JACKSON, CHICAGO

IN THE

Supreme Court of the United States

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No. 392

UNIVERSAL OIL PRODUCTS COMPANY,
Petitioner,

vs.

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Respondent.

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In the

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For the Seventh Circuit

No. 7912

UNIVERSAL OIL PRODUCTS COMPANY,
Plaintiff-Appellant,

vs.

GLOBE OIL & REFINING COMPANY,
Defendant-Appellee.

Appeal from the District Court of the United States for the Northern District of Illinois, Eastern Division.

THE BUNTHORP-WARREN PRINTING COMPANY, 310 WEST JACKSON, CHICAGO

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For the Seventh Circuit

No. 7912

UNIVERSAL OIL PRODUCTS COMPANY,
Plaintiff-Appellant,

vs.

GLOBE OIL & REFINING COMPANY,
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1511 KENNETH G. MACKENZIE, Westport, Connecticut:

Direct Examination by Mr. Theiss.

1238 I am assistant to the vice-president of the Texas Company. I have been with the Texas Company 1239 for nearly twenty-nine years. In 1918 I was consulting chemist with the Texas Company and likewise in charge of its research and control laboratory at Bayonne, New Jersey. I was occupied with the patent matters of the Texas Company. At that time we had no patent attorney and one of my duties, although I am not a patent attorney, was to see that inventions made by employees were referred to patent counsel employed on the outside.

I remember the filing by the Texas Company of an application for patent in the names of Holmes, Manley and Behimer, on or about November 27, 1918, serial No. 263562. About March, 1918, this application was given to me by Mr. R. C. Holmes, with the request that it be referred to some competent patent attorney for such preparation as might be further 1240 required and for filing in the United States Patent Office. The application was immediately referred to Mr. James L. Nesbitt of the legal staff of the Texas Company, since all patent matters were in the charge of our legal department. They employed the patent attorneys and gave such approval as might be necessary for both employment and filing of applications.

1241 DX 599 is the application which I delivered to Mr. Nesbitt in March, 1918, for forwarding to Mr. John M. Coit of the firm of Foster, Freeman, Watson & Coit in Washington. On the first page of DX 599 in my handwriting appears the word "Applica- 1241 1512 tion" with part of the letter "A." The rest 1242 has been punched out. Also in the upper left-hand corner the letters "O. K."

DX 600 is a letter under date of March 22, 1918, from myself to Mr. Nesbitt and refers to four cases 1243 of which Case A is the application which I have al-

ready identified, namely Holmes, Manley and Behimer. In part, it reads:

1244 "It is Mr. Holmes' desire that these applications be submitted at once to some patent attorney for careful inspection and revision. I assume that Coit would be the best man to handle this matter. I believe that these should be sent to him at once with the request that he go over them carefully with a view to broadening, if possible, both the specifications and claims, to the greatest possible extent.

"After he has had opportunity to go over these applications I will confer with him in Washington to discuss the various features with him and establish the prior art.

"I expect to be in Houston about the 5th of April, when the matter of these applications will be taken up. It is Mr. Holmes' wish that our rights be not endangered in any way, and if postponing the filing of these applications until my return might be dangerous, in Mr. Coit's opinion, the cases can be filed as soon as he gets them in shape."

1245 At the time that I received this application A (DX. 599) I read it and I understood it. The application in part reads:

"Our process embodies a novel circulatory system in which a ring of oil is constantly maintained under varying liquid and vapor phases. The oil to be treated on entering this ring is subjected to a high degree of heat, but the time element is so controlled that there is comparatively little decomposition while it is exposed to this external heat, the oil being rapidly removed from the heating zone and conducted to the cracking zone, where without being subjected to additional heat, it undergoes a molecular decomposition whereby carbon and light products are formed. The bulk of the carbon is removed from the ring by withdrawing from the cracking zone portions of the residual oil. The light products continue the

1245 1513 cycle, leaving the cracking zone in the form of vapor and gas. These vapors and gases are then subjected to a reduction in temperature, whereby the heavier constituents thereof such as kerosene, are condensed. The condensate is combined with the charge of oil entering the heating zone thus completing the cycle. The constituents of the desired vola-

tility are removed from the ring and condensed. The outlets from the ring are so controlled that the entire system is maintained under a pressure sufficient to insure the desired molecular transformation.

"Our process is to be distinguished from those of the prior art, in which a ring of liquid residuum is kept in circulation. * * * Any residual oil resulting from the cracking operation will necessarily contain a considerable amount of carbon held in suspension in the oil and to circulate such a residue through heated tubes is to continually pass into such tubes a large amount of free carbon. In our system we do not circulate a residuum, but instead keep the residual oil removed from the application of external heat and withdraw the heavier portions thereof (which contain the bulk of the carbon) from the cycle at the cracking zone, and continue the cycle by means of the vapor generated, which contains the condensable product desired and also certain heavier constituents which are used to complete the cycle. By removing the heavier residuum from the cycle, we keep the ring free from this source of carbon formation, and since we conduct the actual cracking in a vessel unexposed to external heat, we are thus able to effectively remove the carbon formed.

* * * * * *

"In conducting the process with the apparatus illustrated, the oil to be treated is forced through the charging line 7 under considerable pressure, and is rapidly circulated through the heating coil 1, where it is heated to the desired temperature. This temperature is generally from 50 to 100 degrees higher than the temperature at which it is desired to conduct the cracking operation, and ordinarily varies from 800 to 900° F. The oil on being circulated through the coil acquires considerable heat, but on account of the rapidity of its flow, decomposition is only in the incipient stages, the oil being withdrawn into the outlet 9 as cracking develops and is passed into the cracking drum 11 where a constant body of oil is maintained at a cracking temperature. The distributor 9-a serves to discharge the oil into the cracking drum in a wide stream, thus spreading out the vapors and gases in the stream whereby their heat is diffused throughout the body of oil in the drum.

This heat diffusion is materially aided by using a distributor with serrated edges. The rapid circulation of the oil having been suddenly suspended, and the oil having entered a chamber of ample volume, the excess heat of the oil operates to maintain the body of oil at the desired cracking temperature and molecular decomposition is carried on vigorously, the higher boiling hydrocarbons continually breaking up into hydrocarbons of lower boiling point. The vapors and gas generated gather in the upper part of the cracking drum and pass out through the vapor outlet 13 to the separator 15, where there is effected a separation of hydrocarbons of desired volatility from those of less volatility then desired. The hydrocarbons of the desired volatility pass out through the vapor line 16, by which they are conducted to the condenser 18, where they are condensed and the condensate is either intermittently or continuously allowed to run into the collecting drum 21.

1245 1514

"The temperature in the air condenser 15 is such that the less volatile hydrocarbons are condensed and dropped into the conduit 17, by which they are conducted to the jet in the charging line. The separator is preferably somewhat elevated so as to give a considerable head of liquid in the pipe 17, which preferably contains a U bend as illustrated in order to form a liquid seal therein. This head of liquid, together with the high pressure at which the oil in the charging line passes the jet, this pressure being ordinarily from 50 to 100 pounds higher than the pressure in the drum, insures that the condensate shall be constantly drawn into the charging line and forced into the coil 1. The introduction of this condensate into the charging line increases the volume of oil in the heating coil thereby accelerating the flow therein so that the coil is swept free from any carbon formations. This condensate consists in a type of hydrocarbons which when decomposed does not yield any great amount of carbon so that the oil charge is constantly being diluted with oil capable of being decomposed into lighter products without the production of large amounts of carbon. This condensate reaches the jet in a heated condition, preferably at a temperature not materially below its boiling point,

so as to heat the charge of oil entering the heating coil. The heat cycle formed by the kerosene constituents enables the maintenance of the proper cracking temperatures in the cracking drum. By injecting this condensate into the heating coil we increase the volume of oil flowing therein without increasing the total amount of oil in the system at any given time."

1245 1515 DX 601 is a telegram under date of March 27, 1918, which I sent to Mr. R. C. Holmes for the purpose of advising him that Mr. Nesbitt was sick and had not been able to submit the papers to Mr. Coit, and that I was ready to leave for Houston as
1246 soon as he directed for a conference. I went to Houston and attended such a conference. I was there for several days. The decision reached at the conference was that I should stop in Washington on my way back and discuss these applications with Mr. Coit.

1247 DX 602 is a letter under date of April 27, 1918, from myself to Mr. Holmes, which was sent while I was still in Texas. The letter was mailed from Port Arthur on the 27th of April and reads, in part:

1248 "I am planning to stop in Washington Wednesday, and shall leave with Mr. John M. Coit the three applications for patents, as follows:

Coil & Drum—Holmes, Manley & Behimer
Series of
Vertical Stills—Holmes & Manley
Horizontal Re-
tort Apparatus—Manley.

1249 "After Mr. Coit has had three or four days to go over these applications, I will see him again, discuss the whole matter with him and have him draw them up in final form, both as to specifications and claims. Copies of the applications, with oaths to be executed, will then be sent immediately to each of the applicants, as noted above. As soon as these oaths are executed and returned to Mr. Coit, the applications can immediately be filed in the United States Patent Office."

The "coil and drum" application referred to in the letter is DX 599.

1249 1516 I next called on Mr. Coit, leaving the applications with him.

DX 603 is a letter under date of May 3, 1918, from myself to Mr. James L. Nesbitt, and reads, in part:

1250 "I called on Mr. John M. Coit, in Washington, on
1251 Wednesday, the 1st, and handed him three patent applications as follows:

Case A—Coil and drum—Holmes, Manley and Behimer;

Case D—Vertical stills—Holmes and Manley;

Case E—Horizontal retort apparatus—Manley.

"I requested Mr. Coit to go over these applications in order that he might familiarize himself with them, and I will then see him during the coming week at his earliest convenience and discuss with him the perfecting of the applications.

"Mr. Holmes is very anxious that these applications be filed at the earliest possible moment and I therefore took the liberty of leaving them with Mr. Coit in order that time might be saved. I assume that you may wish to confirm this by letter to Mr. Coit."

1251 After confirmation of my verbal instructions had been given Mr. Coit by Mr. Nesbitt, as shown by DX 604 and DX 605, I called upon and conferred with Mr. Coit.

1252 DX 606 is a letter under date of May 9, 1918, from myself to Mr. Coit, which I wrote asking for a definite appointment on May 14, 1918. DX 607 is Mr. Coit's reply. The purpose of my conference was to be sure that the application was not only properly drawn but broadly drawn and that the claims were as broad as the disclosed invention would warrant.

1254 DX 608 is a letter under date of May 31, 1918, from myself to Mr. Holmes, and reads:

1255 "Supplementing my letter to you under date of May 20th, giving the result of my conference with Mr. Coit:

1255 1517 "Mr. Coit is now working on the different applications of Holmes, Manley and Behimer, but we will not wish to file these until the Adams matter is straightened out. As indicated in my letter, the principal question at issue is whether we shall negotiate with Adams on an exclusive or a non-exclusive license.

"I believe we should have Mr. Coit come to New York to confer with us, and I should much prefer to have you present at this conference if you expect to return to New York shortly.

1256 "The Adams appeal on his No. 618,011 will be argued before the Commissioner on the 6th day of June and I assume we will have some decision by the middle of July at the latest.

"I should be glad of your directions as to how you wish me to handle this matter."

1257 The reference to the Adams appeal was to the following: Some time in 1914, as I recall, the Texas Company took an option under the inventions of one Joseph H. Adams. A number of these inventions had very early filing dates and in our opinion were very broad. This one particular application was one of his principal applications and was finally issued some time afterwards after a number of various appeals through the Patent Office.

DX 609 is a letter under date of June 3, 1918, from Mr. Coit to Mr. James L. Nesbitt and was referred to me by Mr. Nesbitt on June 5th with a notation "Would like to talk this over with you." I talked the matter over with Mr. Nesbitt. DX 609 reads, in part:

"I am enclosing herewith the application papers which I have prepared in the case of Frederick T. Manley, docket number 21,805, covering the case marked 'E' by Dr. Mackinzie, and also the papers in

1258 the case of Holmes and Manley, docket number

1258 1518 21,803, marked case 'A'. I am sorry for the delay in this matter but for a while it was due to my own engagements and then I was unable to get the services of a draftsman."

Mr. Coit is now dead.

1260 I desired to have a conference in New York at which Mr. Holmes was present for a discussion of these applications. We had such a conference.

DX 610 is my copy of a letter under date of June 13, 1918, from Mr. James L. Nesbitt to Mr. Coit. That letter outlines the conclusions which were reached at that conference, and reads:

1261 "Perhaps it may serve a purpose if I state my idea of the general conclusions reached in this morning's conference:

"That you will, after action by the Commissioner

on the Adams application Serial No. 618011, advise us of the advantage and protection which would be afforded by the Adams patent and by the claims already allowed in other pending applications in connection with the installations which we are now making.

"That you will determine whether or not there is
1262 such correspondence between the Adams claims and those of the prepared Manley applications,—so-called, now awaiting filing, that an interference would likely be declared between them, and that if, in your opinion, such an interference would not likely be declared then these applications should be filed at once.

* * * * * *

"That in connection with your advice concerning the advantages of the Adams claims, in relation to our installations, you will also express your own ideas as to the particular nature of the interest which we should seek to acquire from Adams; whether a limited or exclusive license or purchase.

1263 "Of course, we would be glad to have you express any other ideas which you may have in mind regarding this whole matter and it may be that I have not covered here all the ground which was gone over this morning but I am giving you my ideas and I am sending copies of this letter to Mr. Holmes and Mr. Mackenzie, in order that if there are any doubtful points as to what is desired they may be cleared up."

1263 1519 DX 611 is a letter addressed to Mr. James L. Nesbitt, signed Foster, Freeman, Watson & Coit, per Coit, under date of June 15, 1918, which was shown
1265 to me by Mr. Nesbitt. This letter reads:

"I have your letter of the 13th instant referring to the conclusions reached at our conference on June 13th at New York and your statement of the matter agrees with my understanding. I am leaving on a vacation of ten days or two weeks but will take this matter up on my return. By that time it is probable that the Commissioner will have rendered his decision. I will, of course, go into the whole matter, keeping in mind the general purposes referred to in the interview and will report to you as to any matter which seems pertinent.

"I am enclosing herewith a copy of the revised

amendment prepared in the Adams Case, No. 618,011. I am filing the original with the Commissioner today."

1266 DX 612 is a letter from Mr. James L. Nesbitt, to Mr. R. C. Holmes, dated July 23, 1918, with a copy to myself, transmitting Mr. Coit's letter under date of July 22nd, in which he stated:

1267 "After going over the Adams cases in connection with the three Manley cases which you left with me last May, I find no reason for refraining from filing the Manley cases. While they include some broad features covered by some of the claims which we have pending for Adams in the Patent Office, they nevertheless include matter which is distinguishable from the Adams construction and process. In other words, while they may come within and be dominated by the broad claims granted to Adams, that constitutes no reason why Manley should not procure patents on his particular differences from what Adams has disclosed. I do not believe that there will be any interference between Manley and Adams, since I will endeavor to so draw all of the Manley claims as to distinguish from Adams. I have heretofore sent you two of the Manley cases all ready for filing, and I am having the third case written out including such claims as I have drawn up."

1268 After I received this letter, DX 612, the ap-
1268 1520 plications were finally executed, although after some delay.

1269 DX 613 is a letter under date of August 27, 1918, from myself to Mr. Holmes, pertaining to the coil and drum application DX 599, and reads:

1271 "I am sending you herewith application prepared by Mr. Coit in the above case, action on which was held up pending determination as to whether or not this application might be thrown in interference with any of the Adams applications. It is Mr. Coit's opinion that there is no danger of such a contingency arising, so that I believe the case should now be filed.

"I do not recall whether you have already seen this application. I have read it over and have but two suggestions to make.

"On page 6 it is stated 'This temperature is generally from 50 to 100° higher than the temperatures

at which it is desired to conduct the cracking operation, and ordinarily varies from 800 to 900° F.' It seems to me, unless we are absolutely sure of our ground, that nothing is to be gained by such a statement, but that the scope of the patent is restricted thereby. I discussed this matter with Mr. Donaldson at Port Arthur but he seemed very positive that
1272 data we had obtained showed that these figures were correct. There is always the possibility, however, that further experiments may develop other temperatures and differences in temperature. If this should be omitted, change would have to be made in certain of the claims which include this temperature difference and range.

"On page 9 it is stated that the product usually contains from 10% to 15% of unsaturated bodies. Here, also, unless we are sure of our ground, I believe that the statement should be omitted. Burton, you will recall, made the same mistake in claiming that condensing under pressure gave him less unsaturated bodies. To be sure, in his case this was probably necessary in order to get his patent, but further researches have I believe demonstrated that this is not altogether true.

"I should be glad to discuss this matter with you, should you care to do so, and will also take up the matter with Mr. Coit next week if you so desire.

"The drawing omits the name of 'Behimer' which of course can be added. I believe it will also be
1272 1521 necessary to have separate oaths prepared so that they can be signed respectively in New York, Houston and Port Arthur. I will determine this definitely."

1273 After writing this letter I conferred with Mr. Holmes. All I can recall of the conference was the two points which I have raised in my letter which I felt unduly restricted the patent, unnecessarily restricted the patent application. After the conference I took the matter up with Mr. Coit.

1270 Our president, Mr. E. C. Lufkin, was vice-chairman of the Petroleum War Service Board. And there were a great many matters in which it was necessary for me to assist him. The manager of our lubricating sales division had been drafted to handle all airplane lubrication for the Army which required very

frequent trips to Washington; and as well I had calls from the United States Bureau of Mines. This work took up most of my time during July and August, 1918.

1273 DX 614 is a letter under date of September 9, 1918, from myself to Mr. Holmes, and reads, in part:

1274 "I saw Mr. Coit on Saturday and discussed the various points in these applications brought up in my recent interview with you.

* * * * * *

"Holmes, Manley & Behimer Application—Coil & Drum.

1275 "On the matter of temperatures Mr. Coit believed that nothing was to be gained by inserting specific temperature limits, since the patent would simply be limited thereby. The only case where temperature limits are of any assistance is where they might avoid some other patent. As we know of no patent having a temperature range, say, outside of 700 to 1000° F., there is no necessity of our limiting ourselves.

"He will make the change, eliminating the percentage of unsaturated compounds.

1275 1522 "I discussed with him the question of a second drum. He stated that he did not believe this was necessary. If we should claim two drums it might be possible for an infringer to get around us by using one drum. If we show one drum, no infringer could add extra drums without using this one drum at the same time, thus infringing the patent. Mr. Coit expressed it as his belief that the addition of one or more drums would be viewed by the Patent Office and the Court simply as additional manufacturing equipment which did not affect the basic idea of the patent. Mr. Coit will put this application in shape and will forward it for signature together with three separate

1276 oaths, so that it may be filed as soon as possible."

After Mr. Coit rewrote these applications, I received them again.

DX 615 is a letter under date of September 13, 1918, addressed to me by Mr. H. A. Thomas, one of the attorneys of The Texas Company. At this time Mr. Nesbitt was ill, and Mr. Thomas was acting for

1277 him and sent the application to me. DX 615 reads:

"Herewith I am handing you copy of a letter this

day received from Foster, Freeman, Watson & Coit, Washington, D. C., with the enclosures mentioned. I presume you will desire to check these applications over before they are signed and sworn to.

"After you have finished with them, will you kindly pass them on to Mr. Holmes for his signature and oath, and for the signature and oath of Messrs. Manley and Behimer in the blank spaces indicated."

And attached to that letter is a letter under date of September 11, 1918, from Coit, which reads:

1278 "I am enclosing herewith the application of Holmes, Manley and Behimer, our docket 21,803 and the application of Manley, No. 21,805, which I have revised in accordance with the understanding reached with Dr. Mackenzie at his interview here a few days ago. These cases should be signed and executed by the in-
1278 1523 ventors as indicated on the papers. You will see that separate oaths have been prepared for the different inventors in the joint case, since I understand that they live in separate places. Each of the joint inventors, however, should sign the specification on the page containing the Manley oath, above that oath."

DX 616 is a letter of September 24, 1918, from myself to Mr. Thomas and reads:

1279 "Referring to your letter under date of September 23rd:

"As soon as I have opportunity to go over the Holmes, Manley and Behimer applications I shall have them executed by the applicants."

Subsequent to that time, I had the applicants sign these applications.

1280 Mr. F. T. Manley signed his oath in New York; Mr. Otto Behimer signed his in Port Arthur, Texas; Mr. R. C. Holmes signed his in New York.

DX 617 is a letter under date of October 1, 1918, from myself to R. C. Holmes and is the letter which I forwarded to Mr. Holmes with the Holmes, Manley, Behimer application, as well as the Manley application. I advised Mr. Holmes that Mr. Manley had already attached his signature to the Holmes, Manley, Behimer application, and that it was now in order for the Holmes signature and oath.

1282 I not only discussed the application with Mr.

Holmes but had directions from him in the matter of securing Mr. Behimer's signature.

DX 618 is a copy of a letter under date of October 22, 1918, from myself to Mr. M. C. Van Gundy,
1282 1524 who, at that time, was the chief chemist of the Port Arthur Laboratory, of The Texas Company where Mr Behimer was located. The letter reads:

1283 "I am sending herewith application for patent, Foster, Freeman, Watson & Coit, Docket No. 21,803, applied for by Holmes, Manley and Behimer. I would ask that you have Behimer read this over in your presence, and if the same is in order have him sign—

First, the petition on the front page, under Mr. Manley's signature;

Second, the first oath on blue paper at the back, under Mr. Manley's signature; at the top of the oath.

Third, the second oath where it is marked for him to sign.

"The second oath, you will note, must be sworn to by a Notary Public.

"I would request that Mr. Behimer be asked to go over this in your office, as I have stated, and that it be not allowed to go out of your possession. As soon as it is signed I would ask that you return it immediately to me by registered mail, personal cover."

1294 The purpose of stating that I didn't wish the application to get out was that Mr. Holmes advised me that it was of the utmost importance that strict secrecy be maintained in the matter of the contents of
1295 this application and I consequently arranged to have Mr. Behimer sign it in Mr. Van Gundy's office in order that, since it had arrived by registered mail, Mr. Van Gundy might immediately return it and there might not be any danger of its falling into other hands for inspection.

DX 619 is a letter under date of October 1st, 1918, Mr. Van Gundy to myself, and which I received from Mr. Van Gundy returning the patent application which had been executed by Mr. Behimer.

1295 1525 DX 620 is a letter under date of October 31,
1296 1918, Mr. Otto Behimer to myself. In this letter reference was made in Mr. Van Gundy's letter and reads:

1297 "I have read over patent claim of application 21803

and believe it would be a good idea to embody a few claims relative to Auxiliary Furnace or Furnaces, and combinations or series of Cracking Chambers. This coil arrangement for treating the Charge and Back Trap is the feature that is sure to make the batteries of two or more such stills such as we have been experimenting on at West Side Pressure Still a success. It seems to me that it would greatly enhance the value of this patent to make such claims as are necessary to make this patent extend to any arrangement of Cracking drums and any Auxiliary Furnaces such as are necessary to maintain the temperature in the single Cracking Chamber or series of Cracking Chambers at the desired Cracking temperature. After the stills have once reached working conditions, this desired temperature (800° F. or nearabout) can be maintained with a very low furnace temperature. In a series of Cracking Chambers, it might require from 900-1100° F. furnace temperature but this is at a perfectly safe temperature to preserve the strength of the iron and prevent hard scaling of the carbon."

1298 DX 621 is a letter under date of November 12, 1918, from myself to R. C. Holmes, informing Mr. Holmes that the application had been signed by the three applicants, and unless he had further thoughts it would be sent to Mr. Coit for filing. Mr. Holmes returned the letter to me with his approval on the side, and the application was sent to Mr. Coit for filing. The long hand note on the side of the letter is by Mr. Holmes and reads:

1299 "Mackenzie. I have no suggestions in the matter 11/16/18 R. C. H."

1300 After this application had been sworn to by the three applicants, the application was filed.

1300 1526 DX 622 is a letter under date of November 18, 1918, from myself to Mr. H. A. Thomas and reads:

1301 "I am sending you herewith application for a patent of Holmes, Manley and Behimer; Foster, Freeman, Watson and Coit docket No. 21,803.

"I should be glad to have you forward this to Messrs. Foster, Freeman, Watson and Coit, requesting them to file immediately and also have them prepare three copies of the application withdrawing, as

filed, one to be sent to Mr. R. C. Holmes, one to Mr. F. T. Manley and one to myself."

1302 The Texas Company operated a vapor phase process at Bayonne in 1916 and 1917. I cooperated in that operation. The operation was in the direct charge of Mr. Louis deFlorez representing the Motor Petrol Company, the owners of the American patents and patent rights.

These four units were installed at the Bayonne laboratory, of which I was in charge, so that I had general supervision, although I was not located at Bay-

1303 onne. I understood, at the time, the operation of these units there installed.

In general, the sketch attached to DX 623 for ident. represents the layout of one of the four Hall process units installed at Bayonne. Oil was drawn from the storage tank G through a pump, through a pressure stabilizing tank for the purpose of killing the pulsations of the pump, then through a filter, then through a meter, then through an oil heater which, as I recall,

1304 did not heat, and then into a coil of one-inch tubes suspended vertically in a furnace in the form of hairpins with connecting U-tubes at the top. Leaving this coil of one-inch tube the pipe then went into a larger tube shown here as an 8-inch diameter, which is

1304 1527 my recollection, and from there into an open cylinder. It entered the top of the cylinder, the product passing out through the bottom into a second cylinder which contained baffles which were perforated. They are shown here as trays, but as trays we usually think of more complicated fractionating means. They were simply plates containing rather large holes at the top but not occupying the space indicated.

There was a coil for cooling the vapors. The vapors passed from the top of the second vertical chamber to the bottom of a fractionating column which contained fractionating trays with what we know as bubble caps, a liquid level being maintained on each tray through which the vapors bubbled to secure fractionation or separation of the heavy material from the lighter.

The heavy material was drawn from the bottom of this fractionating column through cooling coils into

1305 separate storage. The vapors were carried off from the top through a condenser, then into a separator separating the liquid condensed from the more or less permanent gases and light vapors. The light vapors were then taken to a compressor where they were compressed, and the compressed vapors were commingled with the liquid separated out in this separator.

I might say that beyond the separator there was a storage tank of comparatively small size for the liquid condensate which was picked up by a pump so that finally the compressed gases and light vapors and the condensate or liquid were mixed together under high pressure, carried through further coolers and into storage.

1305 1528 A very small amount of very heavy oil was withdrawn from the vertical cylinder or chamber that I have referred to which had the trays and the cooling coil in it. The percentage I do not recall but it was practically infinitesimal.

The material that was withdrawn from the bubble
1306 tower was called light residue.

The pressure, my recollection is, at the inlet, of somewheres around 100 pounds, was just sufficient to force the oil through the tube. There was no valve at the outlet end of the tube. It was simply to overcome the friction of the charge passing through. The temperature for cracking to gasoline was fairly close to 605 degrees Centigrade which, as I recall, is somewheres around 1100 degrees Fahrenheit. There were four of these units. It is my recollection, although I have not seen any of these reports for some time, that we charged three gallons a minute per converter. During the operation of this unit, I made reports from time to time based upon data contained in log sheets which were made during the regular course of the operation by the shift operators under my general supervision.

DX 624 to 635, inclusive, are letters and reports written and prepared by me with respect to this operation over the period from December, 1916 to January, 1918.

1311 DX 626 in part reads:

"Run 24. I would call your attention, however, particularly to Run 24, on which we ran water white

kerosene on all four converters continuously for a period of fourteen days. I am appending herewith a summary of this 14-day run, together with averages of the daily output of four converters and one converter; and averages on tests of the products produced.

"I am also sending you, under separate cover, a section of the bend of one of the converter tubes, taken from the hottest part of the furnace, together with a similar section taken from a new tube, for comparative purposes. You will see from this
1311 1529 that the carbon deposit is practically nil. It should be stated that this tube was used not only for the fourteen days' continuous running, but also for all of the shorter runs in which Converter
1311 #2 was used, the records of which you already have or which are enclosed herewith. There does not seem to be any doubt, in my mind, that either prime white or water white can be run through this apparatus for a very considerable length of time without any appreciable carbon formation."

1313 DX 628 in part states:

"Carbon Formation. The fact that the oil to be cracked in the Hall Process must be vaporized, completely precludes the use of any petroleum product wrich leaves a residue on evaporation. Thus either a burning oil distillate or a carefully distilled paraffin gas oil must be used.

• • • • •

"What Is The Hall Process. Bearing in mind the installation at Bayonne, the descriptions of operation given by Hall and others and the patents, the question may well be asked, What is the Hall Process? The Process, is actually carried out in Bayonne may be said to be:

(a) Passing oil through a coil of tubes under pressure while subjecting it to a heat of about 600° C.

(b) Passing the vapors from the 1-inch tube into an 8-inch tube.

(c) Passing the vapors from the 8-inch tube into three dephlegmators, the first of which is empty. In these dephlegmators the heavier oils are condensed out.

(d) Condensing by a water-cooled condenser as

much as possible of the light fractions, leaving the third dephlegmator.

(e) Compressing the lightest gases and vapors not condensed and after compression mixing them, under pressure, with the distillate from the water condenser.

(f) Finally, condensing this mixture under pressure."

1315 1530 DX 630 in part reads:

"We have tried out two methods of refining of the Hall Motor Spirit.

"The first method is the one proposed by the Motor Petrol Company. It consists in passing the vapors through a column of Fullers Earth of 60 mesh, the column or columns being jacketed so that they may be heated, and excessive condensation of the vapors in the earth prevented. Our experiments have thus far not given any conclusive results. It is true that this treatment not only decolorizes, but also improves the odor of the product; but whether this could be made economical, or whether the earth will become too rapidly exhausted, remains to be seen.

"The other method is a simple acid treat. Mr. Detwiler is somewhat familiar with this since we were working on it when he was at Bayonne. We found in preliminary experiments that ordinary concentrated sulfuric acid was not satisfactory. Not only was the reaction violent, with excessive heating, but the acid stayed suspended as very minute particles for a long period of time, during which periods sulfur dioxid gas was continually evolved. By making a mixture of 50% concentrated sulfuric acid and 50% water the heating up was materially reduced. The sludge separated readily, and after neutralization with carbonate of soda the product could be steam-stilled, leaving a water white distillate greatly improved in odor. The principal difficulty with this method was that there has been an attendant loss of the very volatile constituents, due to heating up. It might be possible to get a product of sufficient purity by treating the heavier ends and then combining the very lightest material, either without treat or with a less severe treat."

1316 DX 632 in part reads:

"Run #101 (June 6, 7 and 8). On this run we used

Paraffin Gas Oil, with steam in the cracking coils in order to see, if possible, whether the use of steam would prevent the excessive carbon deposits which we had found in the dark red paraffin Gas Oil such as we are shipping regularly from Bayonne. It was necessary to use steam from the boilers, which never had a pressure of over 100 lbs., with the result that the feed of steam into the tubes was irregular and our yields consequently varied. The total was also low. We found by the use of steam that the odor
1316 1531 was very much improved and that the unsaturated, as showed by absorption and sulfuric acid, was 10% to 20% lower than on both the residue and distillate samples.

• • • • •

"Summary.

"Carbon. During the runs above recorded we had no trouble with carbon formation in the tubes. In Run #101 we were using Paraffin Gas Oil without redistillation, together with steam. On the recommendation of the Legal Department, however, it was necessary to conclude this test on June 8th. Up to that time there had been no appreciable carbon trouble. Whether steam would eliminate the carbon accumulation from dirty Paraffin Gas Oil remains to be determined.

"Use of Steam. We have proved, from the limited experiments which we have made, that steam, when mixed with the oil vapor in the cracking tube, will reduce the percentage of unsaturated compounds and will give a product with a better odor. Our experiments were not of sufficient duration to be quantitative.

"We have further shown that even the introduction of steam into the vapor line, between the converter coils and the dephlegmator, will appreciably sweeten the resulting product. This is somewhat unexpected since we have believed that the possibility of any chemical reaction in this tube was slight. This fact may have a bearing on some of the Hall patents in which a supplementary cracking reaction is claimed in this vapor tube.

"Refining With Fullers Earth. Because of the fine

grade of Fullers Earth at Bayonne, our experiments in refining the lightest hydrocarbons, and passing them through Fullers Earth were not particularly successful, although the odor was appreciably improved thereby. I still believe it may be possible to use this method for refining the lightest constituents and work will be continued on it.

"Unsaturated Hydrocarbons. The results obtained on these runs confirm our past experience that the percentage of unsaturated hydrocarbons in the naphtha distallate is almost 100% greater when cracking with Paraffin Gas Oil than when cracking kerosene."

1317 DX 634 in part reads:

1532 "Conclusions: As in the Burton Process, we finally condense in the Hall Process under pressure. This gives us a product containing considerable compression gasoline, which is very difficult to hold. We have, moreover, a disadvantage as compared with the pressure still product, in that we have a larger percentage of unsaturated hydrocarbons, and therefore a greater tendency to heat up on acid treating, causing still further loss of the compression gasoline. For this reason I am convinced that the present method of procedure, whereby all of the naphtha, including the compression gasoline, is recovered in one cut, will not be satisfactory in practice. I conclude this assuming that we will use an acid treat for refining. The Hall people propose the use of Fullers Earth which would to a certain extent, possibly, cut down the losses. Work which we did at Bayonne, however, was not satisfactory, the Fullers Earth being apparently very rapidly exhausted. The next possibility was the use of Fullers Earth for the very light product, acid treating the heavier ends. We will work further on this as soon as we finish our run on Paraffin Gas Oil, strictly according to the Hall method."

1318 DX 635 in part reads:

"I am transmitting herewith a record of the Hall Process for the month of October, November and December, 1917.

"October.

"The October figures are divided into two parts; the total is also given, the first covering the period,

up to October 12, in which distilled paraffin gas oil was used, the other period covering from the 12th to the end of the month, in which light yellow paraffin gas oil was used. The total converter hours for this month were 1488 against a possible maximum of 2976.

"November.

"* * * Light yellow paraffin gas oil was used throughout this month with the exception of somewhat less than 900 gallons of Prime White which it was necessary to use in an emergency.

* * * * *

"Observations.

"The most important observations which we have made over this period are as follows:

1318 1533 "1. It is not possible with any grade of paraffin gas oil we have yet tried to get as saturated a product, or, on the average, as high a yield as with Prime White kerosene.

"2. A properly distilled paraffin gas oil, such as the product which we have been running since the 8th of December and testing as follows, may be used without appreciable carbon formation in the tubes over a long period of time.

* * * * *

"3. The light yellow paraffin gas oil mentioned above is a much better material to crack than the redistilled paraffin gas oil obtained from the usual stocks which we market from Bayonne. This is shown by the following distillations:"

The purpose of operating this process at the Bayonne plant of The Texas Company was primarily to determine whether it was a process which we would or would not wish to install in our refineries. We had
1319 an agreement as to licensing rights under this process. I cannot remember all of the details as to our options, but we finally purchased the Hall patents.

1534 *Cross-Examination by Mr. Blenko.*

1319 The installation of the Hall unit at Bayonne began about the spring of 1916. The first run was made
1320 November 23, 1916. At that time the industry was
1321 interested in cracking and the Texas Company was

actively engaged in a substantial amount of research work attempting to develop cracking processes for use in its plants.

The first runs with the Hall process at Bayonne were made with kerosene as a charging stock. Later, a paraffin gas oil was used. The kerosene charge was about 42 Baume gravity; the paraffin gas oil charge was about 36 Baume.

1322 Attempts were also made to crack the light residue produced from kerosene and paraffin gas oil runs in the Hall unit but experience showed it could not be successfully put back through the coils. DX 627 is an accurate summary of the runs made in the early part of the experimentation with the Hall process. This report shows that from February 19th to February 26, 1917, The Texas Company ran the Hall process on a light residue produced from running kerosene, but
1323 found it to be utterly unsuitable for rerunning, because the coils very quickly plugged up with coke. The light residue had to be distilled, to remove a small amount of the light residue which would produce coking in the coils before it could be rerun.

Attempts were made to use the Hall process to produce benzol and toluol for ammunition purposes. DX 627 shows this was from March 7 to March 30, 1917.

1325 The Hall process was always a once-through operation unless you wished to reprocess some of the products for recharging. It was not recycling. The character of the light residue was such that it could not be recycled. It could only be used in another
1535 run at some subsequent date, after distillation, to remove the bottoms.

1326 Neither was it physically possible to recycle the light residue in the Hall operation, because the equipment was not set up for recycling.

The following excerpts from DX 627, relative to the Hall experiments at Bayonne, correctly states the facts.

"Light Residue"

"The chronological record on the running of light residue is as follows:

• • • • •

"This excessive carbon formation occurred, as far

as we could judge, at the point in the coils where the oil was completely vaporized, and might be termed carbon of vaporization rather than carbon of cracking. In other words, this residue will not distil completely without leaving a residue of carbon or coke. Such being the case, it was necessary to distil this residue and this was done, running approximately 90% off and leaving 10% bottoms which would be available for fuel oil but could be worked up into other products."

DX 629 shows that when using paraffin gas oil as a charge, it was found impossible to run longer than 72 hours because of carbon formation in the tubes in the
1327 furnace. The paraffin gas oil which possibly was dark red in color first had to be distilled to a pale yellow color in order to secure satisfactory operation. Kerosene could be run successfully.

The following excerpt from DX 629 correctly states the facts:

"We found, however, that it was impossible to run on this paraffin gas oil longer than about 72 hours, when so much carbon was formed in certain tubes in the front of the furnace that it was necessary to shut down the converter and clean out the tubes. The carbon formed in this case was very similar, and occurred in the same tubes, as that found in running the residue from kerosene without redistillation
1536 and is, in my mind, entirely carbon of vaporization rather than carbon of cracking. This is confirmed, as will be seen below, by the runs on the distilled paraffin gas oil, on which we at the time of writing have been running seven days without any appreciable carbon formation."

1328 Experimentation on the Hall apparatus continued almost without interruption up to the beginning of 1920. The plant was then closed down and subsequently dismantled.

1329 Mr. deFlorez, the representative of the Motor Petrol Company holding the American patents of William A. Hall, and I, supervised the Hall operation at Bayonne.

The Hall process was abandoned because the cost was too high, which was due entirely to excessive formation of fixed gases. The charging stocks used were expensive.

1330 "Q. Your own experimental work showed that the color and the odor could be removed from the Hall product, is that correct?

"A. Oh, it could be satisfactorily treated, yes."

The gasoline from the Hall process and that produced in the Burton process would both perform equally well in a car. Under some conditions the Hall process gasoline would behave better than the Burton.

1333 PX 636 is a letter from me to R. C. Holmes, dated May 5, 1917, headed "Hall Process Construction Expense," setting forth the expenses incurred in installing the Hall process at Bayonne as $64,685.18.

1334 According to a notation by R. C. Holmes on an accountant's tabulation taken from the files of The
1336 Texas Company, entitled "Bayonne Hall Process, Result Operations November 22, 1916, to June 1, 1917," PX 637, the cost of gasoline is 68¢ per gallon. The processing costs of the Hall process are $66,419.91; the return $34,784.16; and the deficit $31,635.75.

1338 PX 637 shows that 7.4% of the charge oil in
1537 the Hall process was converted to gasoline.

1339 In some of the later runs of the Hall process, steam was injected into the heating coils with the oil.

Coking in the Hall vapor phase process took place
1341 at the point in the coil where the material became substantially all vapor. The coke formed at just one particular point in the coil. This appears from page 23 of my final report DX 628 and my supplemental report DX 631.

The Hall process was installed by The Texas Company as an experiment to determine its commercial feasibility. The unit was of a commercial size recommended by Hall. If the Hall process had worked out The Texas Company would have installed quite a number of the Hall units in its plant.

The Hall process was finally dropped because of
1342 the high cost. The apparatus was torn down and never reinstalled again as a Hall process.

Behimer Application—DX 599: The Behimer application was originally the Holmes, Manley and Behimer application, but ultimately issued as a Behimer patent. The Behimer application was referred to as the Coil and Drum case. I had no contact with the

patent work of The Texas Company after January 1919.

1343 The law department of The Texas Company listed the Behimer application as Holmes, Manley, and Behimer, with Mr. Coit's docket number 21803.

I did not intend to overlook any mention, in direct examination, of my discussion with Mr. Coit on May
1344 14, 1918, of supposed conflict with the application of Joseph H. Adams. The Adams applications were being prosecuted by Mr. Coit and The Texas Company had arrangements to have access to the Adams
1538 applications. Mr. Coit was attorney for both the Adams applications and the Holmes, Manley and Behimer application. Subsequently, The Texas Company acquired the Adams patents. The
1346 Texas Company sued Warner-Quinlan in 1925 on one of the Adams patents. The Adams patent which was sued on was the one which was in application form and was being handled by Mr. Coit at the time that it was decided to withhold the filing of the Behimer case.

1349 PX 638 consists of Patent 1,428,338 to Frederick T. Manley; Patent 1,462,143 to Frederick T. Manley; Patent 1,428,339 to Frederick T. Manley; and Patent 1,640,202 to Frederick T. Manley, all assigned to The Texas Company. All these applications were filed in the years 1917 and 1918.

1351 I distinctly remember having seen one or two vertical still cases applied for by Mr. Manley.

Hall Process, DX 626: The end point of the water
1352 white kerosene employed as a charging stock in the Hall process was 548° F. and was satisfactory.

DX 631: The charging stock in the Hall process, "Distilled Paraffin Gas Oil," had an end-point which ran from 564 to 620. This stock was satisfactory.

1353 Gas Oils having an end-point of 710 and 690 respectively were found unsuitable as charging stock for the Hall process.

DX 632: The end point of the undistilled light
1354 residue from the Hall process was 678. I assume this residue would coke the tubes very badly.

1355 Light residues having end points in the neighborhood of 575 might fall into the standard fraction known as kerosene, but would not be particularly good kerosene because of the high end point.

1539 *Redirect Examination by Mr. Theiss.*

1355 I have tried to puzzle out what the blending stock with a yield of 11.16 shown on PX 637 was. Blending stock in general is a product which requires a small amount of a very volatile product such as natural gasoline to give it the right distilling range. I assume
1356 that is the reason since they appraise that on the market at 12 cents and the gasoline at 16. I would assume that was a part of our product in that operation. Of course, I have not seen these figures before. I didn't know of their existence, and have no idea how they were determined.

If suitable for blending with natural gasoline, the blending stock plus the gasoline would be more nearly correct as a yield than the yield that I gave for gasoline alone on that operation. I don't know at all how the thing was figured out or what they concluded was gasoline or blending stock. The record does not
1358 show who prepared PX 637.

Any temperature at all below 605 Centigrade, which is 1121 Fahrenheit, is practically no cracking or gives very little cracking. It seems to be at least as applied to kerosene a more or less critical point. We used that temperature in cracking for gasoline, but if we wanted to produce gas for mustard gas, or tolulol for explosive, it was necessary to go to a higher temperature. In order to crack I think we went as high as 735° Centigrade. As we increased our temperature
1359 we would not have to clean our stock. Apparently the temperature had little effect on the cleanliness of the stock.

As far as we could determine this carbon de-
1359 1540 posit was left on the evaporation of the oil rather than as a result of cracking.

We did not make very long runs even in our work for the Ordnance Department in determining what could be done to the benzol or tolulol or in our work with the warfare service in producing the maximum amount of ethylene for mustard gas manufacture. They were all of comparatively short duration. The Anderson-Prichard case referred to was a case in which The Texas Company was suing under the Behimer patent.

1541 BEN R. SCHNEIDER, Winchester, Mass.:

Direct Examination by Mr. Neuman.

2122 I entered the employ of The Texas at the Port Ar-
2123 thur Refinery in late May or early June, 1916. I was in that employ until late summer or early fall of 1917.

The first part of the time I spent there, was in the drafting room on drafting work. The latter part of the period I spent there on outside engineering work.

2124 After a tracing was completed it was checked for accuracy, details, entered in the tracing record, dated as of the date on which it was entered and completed, and the same date entered on the tracing. The number which was placed upon the tracing was procured from the tracing record and they were taken in numerical order as the tracings were finished.

The date entered in the tracing record and upon the completed tracing would be the date of the completion of the tracing.

2125 I made the original tracing 1703-Y, DX 669, and most of the printing in the title box was placed there by me. The 12 and the 16 on date 12-7-16 are my
2127 figures. I don't know about the 7. There has been a change made, and I don't know anything about it. I do not recall what number I originally placed in this box in connection with the numerals 12 and 16.

2128 DX 733 is a record of all the tracings made in the Port Arthur drafting room. It shows the number of the tracing, the date on which it was made or completed, the title, the scale, the size of the drawing and dates of any revisions that may have been made at a later time.

2128-1542 Tracing No. 1703 is indicated on this tracing record, and according to the tracing record, 1703 was completed on 12-4-16. In view of the tracing record I am now enabled to state that I originally placed the date of December 4, 1916 in the lower box on tracing 1703.

2129 No date appears opposite 1703, but a check mark appears opposite 1703; the check mark is just a ditto mark, being the same date as the date shown above,
2130 and the preceding date is 12-4-16. The notation "High pressure still experiment 2000" is in my handwriting.

The date 1-29-17 appears in connection with the printed word "Revised" in the box in the lower right-hand corner. There was quite a discussion concern-
2131 ing whether the end of this trap should be riveted or welded; there was some question whether welding would be safe for a high pressure still, and we finally changed it to a riveted construction rather than a welded construction. This constituted the revision.

The changes I made in connection with the revision are: Under "Specification" for 2-inch, 2-foot zero diameter drum, there is an erasure shown on the drawing and the word "Riveted" is printed in. After that sentence there are the two words in parentheses, "See below," which I then added. I added the word "Riv-
2132 eted" and the parenthetical matter. And that note, "See below" refers to the two last sentences under "Specification" for 2-foot zero diameter drum and covers the rivet spacing specifications for the dished head of the drum.

2133 It was always our practice to enter the revision date in the tracing record.

Those figures 1-29-17, appearing under the
2133 1543 column "Revised," in DX 733 are definitely in my handwriting. I wouldn't know whether underneath there there were some other figures at one time.

2134 The job of the preparation of the DX 669 was handed over to me directly by the head of the drafting department, Mr. Higgins, who issued all jobs to be done. The one person I know distinctly that I worked with in connection with the preparation of the drawing, was Mr. Behimer. Of course, I worked with the chief draftsman as well.

1544 *Cross-Examination by Mr. Hall.*

2135

2136 DX 669 is a tracing made on December 4, 1916. Re-
2137 visions on this tracing were made on January 29, 1917 as shown by the tracing records.

1545 WALTER H. ELLIOTT, 17 Priscilla Avenue, Tuckahoe, New York:

Direct Examination by Mr. Neuman.

3853 I am assistant to the manager of maintenance and construction, refining department, Texas Company.

I entered the employ of The Texas Company at Port Arthur in October, 1916. At that time, I was engaged as draftsman. I stayed there as a draftsman until March, 1919. I became chief engineer 3854 about January 1, 1923. Prior to that time, I had been chief draftsman. I remained as chief engineer at Port Arthur Works until June 1, 1926.

As chief engineer I was in charge of the engineering department, the men, the personnel, the records and the engineering activities. The drafting department was a part of the engineering department. I supervised the drafting activities, the design and the layout and the general direction of the preparation 3855 of the drawings and the keeping of the records and the files and the system used in the drafting department as well as my duties outside.

At Port Arthur from 1916 until 1926 it was the practice when a drawing was laid out and drawn up to assign it a number, which was taken from the tracing record, and the corresponding title to the drawing was recorded in this tracing record, and then it was blueprinted and sent out to the parties interested and then it was filed in its respective place.

We had a rather large vault, in which there were 3855 1546 cabinets made purposely to hold the drawing, with thin drawers in which they were laid out, and it was subdivided according to the classification of the particular type of work, i. e., crude stills or pressure stills or lubricating department. Then the drawings were filed under these general classifications according to number. Drawings were 3856 1547 also kept by the draftsmen in their drawing tables in which there were drawers. The tracings or drawings at the Port Arthur drafting department while I was chief engineer ran into thousands.

The practice at Port Arthur relative to keeping

records of blueprints was that we had a blueprint record book in which there were serial numbers, and as the blueprints were made they were recorded in this book and a corresponding number placed on the blueprint, and it was indicated in the record as to who the print was sent to, and the date, and so on.
3857 We generally kept that blueprint record, probably, for a year or eighteen months, or something like that, and then destroyed them. The records were too voluminous and accumulated too fast.

I met Mr. John S. McCarthy through Mr. Donaldson about March, 1926. Mr. Donaldson brought Mr. McCarthy over and said that they wanted to search for a tracing that had been missing, and so I accompanied them to the vault and showed them the general location, according to the system that they had, where they would likely locate this or where they
3858 should look for this particular tracing. They came back later on and made another search. On this second occasion Mr. Mace was there, Mr. Donaldson and Mr. McCarthy. They came into the office and I took them out to show them where the records were kept and indicated to them the general procedure. Mr. Mace said he wanted to make a very thorough search of the whole vault, more or less turn it upside
3859 down, in an effort to endeavor to locate this tracing, so I went out and authorized them to go ahead with the search on that basis. They were there for several days. I showed them the cabinets where the
3859 1548 drawings were kept and then showed rolls of tracings and old drawings that were up on top
3860 of the cabinets. I further said that they might look through the draftsmen's desks to be sure that they weren't, by chance, in any of their desks.

1549 *Cross-Examination by Mr. Blenko.*

3860 The tracing records were kept by numbers and recorded in the tracing record book and were entered. As the drawings were made they were assigned the next number and the size was indicated by the prefix of a letter. As the tracings were completed they were assigned numbers in serial order, consecutively. The earlier numbers would indicate that that drawing was made earlier, but that is not necessarily so.

3861 Our practice was to assign the number first and if when that drawing was made we should find for any reason that we had to go back and add to it or elaborate on it, it may be that the draftsman would assign a different title and a different name to the print, and they might then assign another number to the drawing although it was started or worked on prior to the additional information and then the old numbers were kept aside for assigning to other drawings as and when they were made.

3862 We had a practice of voiding drawings, as a rule, when they were traced over. If another drawing had been prepared and traced over we voided that. The record corresponding to the number of that drawing in the tracing record would be appropriately marked. The practice was to change the title to correspond to that number of the new drawing. The tracing record was the only official record of the drawings prepared in the drawing room. Whether all of them were entered in the same record depends on the nature of the drawing as to what it was intended to cover.

1550 For example, we made a practice of making a lot of miscellaneous sketches. In that case, there may be just a sketch prepared and given out, and

3863 there might be no number assigned to it. The tracing record was the official record of drawings which had reached such finality that a tracing number had ben assigned to them. The numbers thus assigned remained on the records as identification of that particular drawing although occasionally it was necessary to make changes in this record.

3864 In such cases the record of the old drawing was not necessarily preserved. The tracing record was preserved. As a general rule, the tracing record which was preserved would give the key as to the original drawing, both by number, title, date and date of revisions, with the exception of the changes which might possibly be made later on, that is, when the substance of the drawing was sufficiently changed it was sometimes given a new title and a new number, and then the previous drawing number or tracing

3865 number which was assigned to that was stricken from the book, and the draftsman kept a record of that

number and as and when new drawings were prepared he then assigned that old number to a new drawing.

1551 JOHN S. McCARTHY, Cliffside Park, New Jersey:

Direct Examination by Mr. Neuman.

3844 I am a member of the firm of Schwarz, Hughes & McCarthy, patent engineers and investigators. For the past twenty years personally the principal part of my work has been the investigation of the development of patented structures and processes and the collection of documentary proof to establish the dates of conception, and so forth, in courts or in litigation,
3845 patent litigations. I conducted an investigation for The Texas Company at Port Arthur, Texas, in the spring of 1926, relating to the various stages of development of an oil cracking process which The Texas Company referred to as the coil and drum
3846 clean circulation process and apparatus. Mr. Dearborn, patent counsel for Texas, employed me to obtain if possible all the documentary proof of the development of the so-called coil and drum apparatus, its construction and operation. Mr. Donald Mace, who was Mr. Dearborn's assistant, went over the
3847 situation thoroughly with me and gave me a photostat of a blueprint like DX 667, this same apparatus. Mr. Mace instructed me to make a very careful search during my investigation for the original tracing from which the blueprint, of which I had a photostatic copy, was taken, to make a careful search for the tracing.

3848 At Port Arthur I personally made a search of Otto Behimer's files, made a search of the research laboratory files, made a search in the files of the
3848 1552 chief engineer, Mr. Elliott's department,—the drafting department. Mr. Elliott at that time was chief engineer. The search that I made in the drafting department was for the original tracing. In the drafting department I searched the drawers
3849 in the vault where all the tracings were kept, espe-

cially where Mr. Elliott thought if the tracing was in existence it would be. He pointed out certain drawers to search. He pointed out the drawers in the various cabinets to me, miscellaneous drawers and voided drawers, and places of that kind.

Then we searched what I would call inactive general files that had been stored away on account of
3850 their early use, for instance for the periods 1915 to 1918 or 1919. Those are files of all the general departments, all the departments of The Texas Company there at Port Arthur, all these various offices and departments and everything.

3851 I did not find the original tracing or drawing at that time.

Some weeks later, about the first of May, Mr. Mace came down to Port Arthur and went over all the data that I and Mr. Donaldson had previously collected, and then Mr. Mace and myself went down to Behimer's office and made another search, a very thorough search, of everything that was in there. Later Mr. Mace, Mr. Donaldson and myself went over to the engineering department and received authority from Mr. Elliott to look at every scrap of paper that was in the files of the drafting department, and we spent four days. Personally I handled practically every tracing that was in the various files,
3852 including large bundles of tracings, paper and cloth tracings, that were thrown up on top of the cabinet files. I took them all down. These bundles
3852 1553 had a diameter, perhaps, of 6 or 8 inches, and we inspected each one of those. I looked all through the cabinets, all through the drawers of the various draftsmen there. We made a thorough search and went all through them. I did not find the tracing. There were several thousand tracings, maybe two or three thousand tracings there.

No cross-examination.

1555 IN THE UNITED STATES CIRCUIT COURT OF APPEALS,

For the Seventh Circuit.

7912.

Universal Oil Products Company,
Plaintiff-Appellant,
vs.
Globe Oil & Refining Company,
Defendant-Appellee.
} Equity No. 10744.

CERTIFICATE.

This is to certify that the following consisting of a bound volume is a part of the abstract of the record to be printed by the Clerk in accordance with the stipulation of the parties filed and approved by Evan A. Evans, Judge of the United States Circuit Court of Appeals, on March 24th, 1942.

Alexander H. Reichmann,
Attorney for Plaintiff-Appellant.
J. Bernhard Thiess,
Attorney for Defendant-Appellee.

1560 HOWARD V. SMITH, Westfield, New Jersey:

3044 *Direct Examination by Mr. Von Holst.*

3045 I am a graduate of the University of Kansas with a degree of Bachelor of Science in chemical engineering. I have been actively engaged in the business of oil refining since January of 1924. I entered the employ of the Skelly Oil Company in 1924 and was in the employ of that company at its refinery in Eldorado, Kansas, until June, 1938, at which time I resigned to take the position of chief chemical engineer in charge of research and development for the Barber Asphalt Corporation at Barber, New Jersey, the position I now hold.

During my employment with the Skelly Oil Com- in active charge of all the processing of the

pany I was assistant superintendent of the refinery from January, 1927, until I resigned in 1938.

Prior to 1927 I was employed successively as a chemist, as an operating foreman, and as a development engineer in the plant. The Skelly Oil Company at the time when I joined the organization was just putting into operation its first cracking stills.
3046 These were three, a battery of three stills of the type known as the Jenkins cracking still. During 1924 the company also installed and put into
1561 operation two units of the Cross cracking process.

In 1925 three additional Jenkins stills were added to the plant's cracking facilities.

In 1927 we installed a cracking unit of the high temperature vapor phase coil and tank cracking type. In 1928 we started the erection of two cracking stills of the Winkler-Koch type and put these into operation early in 1929.

I failed to mention that in 1927 six additional Jenkins cracking stills were put into operation.

In 1931 we put into operation a third cracking still of the Winkler-Koch type.

In 1936 we installed a coil cracking unit of our own design.

During my employment as a chemist in the laboratory of the company I was in intimate contact with the cracking operations from the standpoint of the laboratory; that is, the activities of the laboratory
3047 were very much influenced by the addition of these new cracking units and working out the problems which were occasioned by the installation of these units.

In my work as an operating foreman I was in charge of the vapor recovery plant and our principal source of gas for the operation of this plant came from the cracking stills, so that I was in intimate contact with the operation of the cracking plant in connection with my duties there.

In the work as a process engineer, most of my activities were connected with the development of the cracking operations.

3047 1562 As assistant superintendent of the plant I was

plant, including the operation of the cracking stills. They were directly under my control and I was responsible for their operation.

In my present position with the Barber Asphalt Corporation I am naturally in contact with the operations of the cracking plant which the company operates in its refinery at Barber, New Jersey, from the standpoint of the research and development work.

3048 The purpose of the development of this 1927 Skelly vapor phase still was to produce a gasoline of very high anti-knock value which was used in preparing a commercial product which was sold at a premium price in competition with the premium price Ethyl gasoline being marketed at that time by the Standard Oil Company of Indiana in Skelly's marketing territory.

Q. Will you briefly describe the cracking process and its importance and what we practice it for?

A. Cracking is a word which has a special significance in the oil refining industry. Petroleum as it comes from the ground is composed of a large number of hydrocarbons, each one of which has its own particular properties such as boiling point, freezing point, color, refractive index, and so forth. In commercial refining of petroleum with a few exceptions we do not attempt to separate out the invidiual hydrocarbons but rather separate out a fraction or cut of the petroleum which has proper-

1563 ties which meet particular commercial requirements. That is, for example, gasoline is made

3049 up of the hydrocarbons which boil through a range of from about atmospheric temperature to approximately 400 degrees. Kerosene is made up of a group of hydrocarbons boiling in a range of approximately 350 to 550 degrees. Furnace oils used for domestic heating purposes, are somewhat higher boiling ranges. Gas oils are of still higher boiling ranges, and so on, these various fractions are separated out from the crude oil.

Commercial demands for the different fractions control the price at which these fractions can be sold. In the days when kerosene was the principal product from petroleum, it commanded a higher price. With the coming of the automobile and its use in large

numbers, a demand for gasoline motor fuel developed which had the effect of raising the price for gasoline. This higher price for gasoline is a natural development, of course, because the amount of gasoline naturally occurring in petroleum is limited by the characteristics of the particular crude oil. And as the demand for gasoline in excess of its availability develops, it naturally tends to raise the price above
3050 the other fractions of petroleum.

With higher prices for gasoline it naturally becomes desirable for the refiner to put as much of his petroleum into gasoline fractions as he can. This led to the development of commercial cracking for making gasoline because the cracking operation enables the refiner to put more of his crude
3050 1564 oil into the gasoline which commands a higher price.

Now the cracking operation itself is a chemical process in that it chemically alters the heavier constituents of the petroleum so that some part of those constituents become materials boiling within the gasoline range, and hence may be used in the gasoline. This chemical reaction is brought about by the application of a high temperature to these heavier fractions for a period of time, and the chemical reaction which takes place breaks up some of the heavier molecules, the larger molecules, into smaller molecules which then are available for use as gasoline.

Q. What is the significance of the term "cracking"?

A. Well, cracking is a word which developed a
3051 great many years ago. As I understand it, it originated back in the days when kerosene was the primary product desired from petroleum. It was found in those days that the yield of kerosene could be increased by conducting the distillation of the crude oil at a slower rate during the time when the kerosene was coming off. In this operation, carried on slowly, some of the vapors would be condensed and dropped back into the still and there subjected to additional time at the temperature at which the distillation was carried on. The dropping back of these condensed vapors entailed an agitation or noise in the still which was sort of a popping or frying

noise similar to that which we get when water or a small amount or drops of water are dropped
3051 1565 into hot fat. This was probably due to the presence of a small amount of moisture which might condense in some parts of the apparatus and drop back with the condensed vapors. But this type of distillation came to be known as a cracking distillation because of this cracking or popping noise. Whether or not that is the true origin of the word cracking, nevertheless that word is descriptive of
3052 the cracking operation because in this cracking operation by the application of high temperature for a period of time we do crack or break the large molecules into smaller fractions. Cracking may take place at very slow rates at relatively low temperatures, but for commercial considerations we generally say that cracking begins as a temperature of about 700 degrees.

Q. Will you explain a little more in detail the time factor in cracking?

A. Cracking being a chemical reaction it is not brought about by the application of temperature alone. Temperature must be applied for a period of time in order to bring about substantial cracking. We might make an analogy to this in the operation of baking a loaf of bread. We do not create a loaf of bread out of raised dough simply by heating the dough to a baking temperature, we have to put the dough in the oven and heat it up and then keep it there for a period of time in order to make a finished loaf of bread. Likewise, another example would be,
3053 boiling a potato. We cannot create a boiled potato simply by heating the potato to a boiling tem-
3053 1566 perature. We have to heat it to a boiling temperature and then boil it for a period of time in order to produce a boiled potato. In the same way, cracking is accomplished by applying a cracking temperature to the oil for a period of time and, of course, the longer we apply any particular cracking temperature to a particular oil the more cracking we get.

Q. What relation is there between temperature and time in oil cracking?

A. Well there is a rather definite relationship between temperature and time, in this way, that the

higher or greater the temperature used the faster the rate at which cracking progresses. For example, assume a particular oil which might crack, we will say, at the rate of one per cent an hour. That is, one per cent an hour at 710 degrees, we will say. By that we mean that if the oil is subjected to a temperature of 710 degrees for a period of an hour, one per cent of it would be converted into gasoline.
3054 If we subjected it to that temperature for two hours we would have two per cent of gasoline. If we raised the temperature, say, to 730 degrees then we would find that the cracking progresses twice as fast. In other words, we would get two per cent gasoline formed in that period of an hour or we would get one per cent gasoline formed in a half hour. Another raise of approximately 20 degrees, say to 750 degrees, would again double the rate at which the oil cracked and we would find that we would get one per cent of gasoline produced
3054 1567 in a quarter of an hour, or we would get four per cent of gasoline in an hour. These facts have led to what has become known as the doubling rule which states that the rate of cracking doubles for an increase in temperature of approximately 20 degrees Fahrenheit.

Pressure seems to have very little effect upon the cracking reaction itself because the oil will crack at a particular rate at a particular temperature regardless of the pressure. Pressure does have some col-
3055 lateral effect however in an oil cracking operation.

Pressure serves different purposes in cracking operations, depending upon the type of cracking operation being carried out. If the operation is one in which it is desired to crack the oil in the liquid state then pressure is used to hold the oil in a liquid state at the temperature at which it is desired to crack. That is, a particular oil has a range of temperature at which it boils at atmospheric pressure. That particular oil which it is desired to crack may boil or vaporize at a temperature below a temperature at which it would crack at a useful rate. Now by the application of pressure to that oil we raise the temperature at which it vaporizes and by the application of enough pressure we may raise its vaporizing temperature to a temperature where it will crack

at a desired active rate in the liquid state. If the desire in the cracking operations is to crack the oil in the vapor state or in the mixed liquid and vapor
3056 state irrespective of its condition, then pres-
3056 1568 sure serves the purpose of squeezing a given quantity of vapors into a smaller space so that with a particular apparatus we may have a larger amount of oil under treatment and undergoing cracking at a higher pressure than we would have at a lower pressure, and it thereby increases the capacity of that particular piece of apparatus.

Cracking is essentially a breaking of larger molecules into smaller molecules. In that reaction invariably we find that some of the fragments or smaller molecules are so small that they are not condensable at ordinary atmospheric temperatures and pressures, and they are the fixed gas which is produced in the cracking operation.

Others of the molecules formed by the cracking reaction are large enough in size so that they come within the gasoline range.

Now the cracking reaction is not simply a breaking
3057 up of larger into smaller molecules because some of these smaller molecules or fragments which are formed in the initial break are very reactive and they unite with each other to form larger molecules again in turn. These larger molecules formed in this way may again break up in the same way and parts of them may again recombine. And this breaking up and recombining operation may take place in the myriad forms and varieties of reactions, but the ultimate result of that in so far as the products formed in the cracking are concerned, is that we find developed in the cracked oil some materials
3057 1569 of higher molecular weight or higher boiling point than the materials with which we started. These materials which are formed by this uniting and breaking up and reuniting reaction which we classify, the uniting reaction, as polymerization reaction,—these materials in general are richer in carbon and leaner in hydrogen than the materials with which we started. These polymers, if the reaction is allowed to progress far enough, become so carbonaceous, so lean in hydrogen that they evidence themselves by a darkening or blackening in color of

3058 the material, and if it is carried on long enough they become so carbonaceous that they become less soluble in the remaining part of the oil and finally they may actually become insoluble in which condition they will separate out and attach themselves to any surface with which they come in contact. When they do that we have the development of these cokey and carbonaceous masses which may be developed in these cracking processes. Short of that point the materials are in the form of so-called tars or asphaltenes.

3059 In the breaking down of the larger into the smaller molecules, it is not now believed that the recombining into coke to which I have referred, occurs instantaneously. The coke formation is the end result of this series or chain of reactions, breaking apart, reuniting, breaking and reuniting, and so on, so that we may have a considerable amount of cracking take place before we arrive at the point of carbon or coke formation.

3059 1570 This was not always the belief, to my knowledge. The belief some years ago was prevalent that when the large molecules broke in the cracking reaction that an atom or atoms of carbon were formed as part of the fragments produced in that breaking operation; and these carbon fragments were responsible for the coke formation. The initial cracking, of course, it was believed produced these in small amounts so that the carbon might remain suspended in the cracked products and not evidence itself by precipitating out until the cracking reaction had progressed to a considerable degree. But that belief,

3060 I think, has universally given way to the belief of the present day that carbon or coke is formed as the result of this chain of reactions, breaking up, polymerization, breaking up and repolymerization.

When I entered the field in 1924, the cracking field, the belief, as I learned oil cracking at that time, was that this carbon formation was the result of producing carbon fragments in the breaking up of the larger molecules.

Q. Now, in this question of carbon formation, does that or does it not vary with different stocks?

A. Yes.

Q. Will you explain how that affects the cracking operation one may desire to conduct?

A. We may apply the cracking operation to a wide variety of stocks. If we apply the cracking reaction, for example, to a gas oil stock which is a clean distillate stock, the cracking reaction has to progress to a considerable extent before this chain
3060 1571 of reactions has progressed far enough to develop a cokey or carbon product. If, on the other hand, we start with a dirty stock like a reduced
3061 crude or residue from a cracking operation, we have in those stocks materials which are already pretty well along on this path of carbon formation as they have in them some of these heavy carbonaceous asphaltine materials, and they will develop the coke or carbon with a relatively small amount of cracking. That is, the path which they need to go through before they reach that carbon or coke condition is a much shorter path than the path which the clean stock has to follow in reaching that condition.

If you took a sample of residue from a cracking operation, which had been cracked good and hard, and looked at it casually in comparison with a sample of topped crude or reduced crude, you would notice
3062 that in both instances we see that the material is black or brown or at least a very dark color, and the material which makes these stocks dark color is the material which, when it is cracked, readily develops coke or carbon.

The residue from the cracking operation gets its black color as the result of cracking reaction which the stock has undergone, and the chain of reactions of cracking, polymerization, cracking and polymerization, and so on. The reduced crude or topped crude probably has gone through some sort of a similar development in the millions of years which were required in its formation in the earth.

3062 1572 From the standpoint of carbon deposition in the still, in the cracking process, the still would have no way of discriminating between the two. The
3063 carbon formation depends upon the character of the stock itself and if we have these heavy asphaltic carbonaceous materials introduced from or originating from the reduced crude, why the still has no way of distinguishing between those and similar materials

which might be introduced from a stock which had been previously cracked.

3064 "Vaporization" as used in the oil cracking art means the formation of vapors, that is a change of state from liquid or solid to the vapor state. That meaning as used in the art is not any different from the meaning as I am familiar with it in physics and
3065 chemistry and in the ordinary phenomena. That has been my understanding of the meaning of vaporization ever since it had any meaning to me at all. I probably first became acquainted with the meaning of the word in high school.

Vaporization occurs as the result of the application of heat to a material. That is, we must impart heat to a liquid or a solid material in order to change it from the liquid or solid condition to the vapor condition. Now that is true unless we reduce the pressure on the material, in which case vaporization may take place with a decrease in temperature of the material. That is the heat required for vaporization is supplied by a reduction in temperature of the material.

This heat that is consumed in the vaporization process is called the heat of vaporization or
3065 1573 sometimes called the latent heat of vaporization.
3066 That term is used in the oil cracking art. The word "vaporization" itself is used very extensively in the oil cracking art.

Evaporation is a word applied to, applied in general to an operation in which we are concerned with the material which is left behind after the vaporization takes place, rather than with the material which vaporizes. For example, we speak of the evaporation
3067 of maple syrup to create maple sugar. We are not concerned there with the water which evaporates out of the syrup but we are concerned with the sugar which is left behind. We speak of evaporation in connection with the water evaporating out of ponds or streams. We have no visible evidence of evaporation taking place except by what happens to the material left behind. We notice the decrease in the amount of water which is left there. We speak of the evaporation of gasoline, for example, which takes place in the tank in the motor car. Some of the gasoline vaporizes and is lost. We only notice there the effect upon the

properties of the remaining gasoline, or we notice by the fact that we have less gasoline in the tank.

Ebullition is generally applied to an operation where the vaporization takes place at such a rate that we see active formation of bubbles within the material.

Distillation is applied to an operation in which we are concerned with the vapors which are produced by the vaporization; that is, we wish to recover
3068 1574 those or save them in some way. We apply distillation to the operation of recovering alcohol from a fermented solution or distillation where we wish to recover the distillate products in petroleum refining. That is, the distillation operation concerns itself with actually recovering the materials which have been vaporized.

The steps present in any distillation process are first of all vaporization, of course, and then the passing off of the vapors into some receptacle. The vapors may be collected in the vapor state, retained in that way as in the distillation of liquid air, or they may be condensed back to liquid and recovered in the liquid state as in the more common distillation operations such as in petroleum, alcohol and so forth.

3069 Vaporization takes place in the defendant's cracking coil in a progressive manner in this way, that we have fed into the cracking coil a stream of liquid oil. That stream of liquid oil is heated and cracked as it progresses through the coil, and it reaches a point in the roof tubes where it begins to vaporize.

Now when the oil is heated in its progress through the coil and before vaporization starts, there is some expansion of the oil due to the increase in temperature, just the same principle that causes the steel rails to expand in the hot sun. But that expansion is relatively small. When vaporization starts, however, the vapors which are formed necessarily occupy a much larger space than they did while they were
3069 1575 in the liquid condition. They have to push some-
3070 thing out of the way in order to form. They cannot push back against the pump, so they have to push the material which is ahead of them on to the outlet of the coil. And this expansion which takes place when the oil vaporizes results in pushing the stream ahead at a constantly faster rate, so that we have a rather rapid acceleration of the velocity of the

stream of oil when vaporization starts and as it continues throughout the remaining portion of the coil.

Supposing that we had the end of defendant's coil capped in some manner and the coil full of liquid oil, and you applied heat, you would not then get vaporization. If you did not provide some way for the vapor to expand then it cannot form, of course, and you simply develop more pressure in the coil, and if you continue that of course you would have a pressure developed eventually sufficient to break the coil, cause a rupture of the pipe.

Let us assume a kettle or a vessel with a closed lid tight on and just an outlet of any length, and assume
3071 that the kettle is full of oil and that you are supplying heat sufficient to cause rapid vaporization, or boiling of the oil, those vapors as they are formed in the body of the oil will rise to the surface, pass up into the vapor space and on out the spout. If that same kettle is so mounted that instead of being stationary it is in violent agitation, some reciprocal motion that will keep it all churned up inside, half full and all
3071 1576 churned up, the same things happen, of course, except that instead of the vapors being able to rise to the surface of the oil and escape, they remain mixed up with the oil, and with that sort of a condition instead of just having the vapor pass out the spout you would have a mixture of vapor and liquid pass out the spout. You would have the same vapor formation, the same amount of vapors formed and that would be absolutely the only difference.

3072 Heat is consumed in cracking, first of all in raising the temperature of the oil to the cracking temperature. That heat we call sensible heat, the name being derived from the fact that effect of heating is perceptible to the senses just as, for example, we take a pan of cool water and apply heat to it we can notice the effect of that heat by putting our hands in the water, we find that the water becomes warmer until if it is continued, it becomes uncomfortable and finally would result in a burn. That is sensible heat.

Then when the oil reaches the cracking temperature and commences to crack, we find that heat is consumed in the chemical reaction of cracking itself, that is it takes heat to bring about this cracking, this breaking up of the larger molecules into smaller molecules.

Heat is absorbed in the chemical reaction, and we call that the heat of reaction.

We also find that heat is absorbed in the vaporization operation; that is, when the oil starts to vaporize, whether as a result merely of its natural vapor pressure or as the result of the vapor pressure
3073 1577 brought about by the cracking, this heat is absorbed in the vaporization action itself, and that heat is called the heat of vaporization or the latent heat of vaporization. Latent heat, the adjective "latent" is applied because in dealing with a pure compound vaporization takes place without a change of temperature, heat is absorbed and we do not find any change of temperature, we merely find that vaporization has taken place.

In a vaporization of a mixed liquid like petroleum, the thermometer does not cease to rise at a given point when vaporization begins. In the vaporization of a mixed liquid we find that as vaporization progresses the temperature actually does rise. Now that is brought about by the fact that when vaporization of this mixed liquid starts, we find that the constituents of the liquid which have the lower boiling point are vaporized to a greater extent than the constituents which have a higher boiling point, and consequently the vapors which come off are richer in the lower boiling constituents than they are in the higher boiling constituents. That as it progresses, of course, strips
3074 the residual liquid of some of the lower boiling constituents thereby changing its composition somewhat and the changed composition causes the oil to boil at a progressively higher temperature.

3078 I may have one of several meanings in the use of these words "liberation" or "separation", which I take to be synonymous. We may speak, I may speak
3079 of the separation which takes place when vapors
3079 1578 pass off from a vessel, as for example, when the vapors pass out of the spout of a tea kettle. That would be a form of separation or liberation. I may use it in the sense of segregation, such as takes place in a container, let's say, like in a bottle, in a seltzer bottle for example, we have separation there because the water solution is segregated in the lower part of the bottle and the gas is segregated in the upper part of the bottle. Now that is a form of separation.

Another form of separation or liberation is that which takes place when vaporization itself takes place in the sense that some of the molecules of the liquid or the solid separate or liberate themselves from the remaining liquid or solid molecules. Now that is the form of separation or liberation which takes place when a bubble is formed in a body of liquid, or it may occur at the surface of the liquid, the quiet surface of the liquid. It is the actual transformation of the liquid or the solid from that state into the vapor state. In that sense, liberation or separation is identical with
3080 vaporization itself. It is the molecular transformation of the liquid or solid state into the vapor state.

The Court: Q. In any one of the four examples you have given?

A. I just gave three, your Honor.

The Court: Three, I see. In any one of the three.
3082 When vapor bubbles form and rise to the surface of the liquid and pass off, vaporization does occur, and it occurs when the vapor bubbles form.

3082 1579 The rising of the bubbles to the surface of the liquid and their passing off therefrom is not vaporization or any part of vaporization. Those things are something which follow the vaporization step.

3083 I have said that liberation or separation of vapors might mean to me the segregation of vapors from liquid. Segregation in that sense, or separation or liberation in that sense of segregation, is no vaporization.

I gave the example of a seltzer bottle partly full of water, the remainder of the bottle being filled with gas. That represents a condition of segregation. Now, if I take that seltzer bottle and shake it up violently so as to thoroughly mix the gas or vapor part with the liquid part, then I no longer have separation or liberation in the sense of segregation.

If I set the bottle down once more the two segregate again.

In those operations where first I mix the two phases intimately together and then, second, permit them to separate or liberate in the sense of segregation, there was no formation of vapor from liquid, there was no condensation of vapor into liquid, merely a mixing.

Since there was no formation of vapor from the li-
3084 quid there was no vaporization in that operation.

Liberation or separation of vapors might mean to me the passing off of vapors from the vessel. This is not vaporization.

3084 1580 The passing off is a form of separation or liberation which has nothing to do with the vaporization itself. Vaporization might take place at some point remote from the vessel, as for example if the liquid were being heated in a coil and discharged into the vessel, vaporization could take place in the coil itself. Then after the vapor and liquid is discharged into the vessel the vapor would separate and pass off. Now the vaporization in that case takes place outside of the vessel before the material enters the vessel. The separation in the sense of passing off is something subsequent to the vaporization.

I think the meaning of separation or liberation as the molecular flying off of vapor is perhaps a little more difficult to understand. Our concept of vapor-
3085 ization, that is the formation of the vapor state from the liquid or the solid state, is that some of the molecules of the liquid or the solid disengage themselves from the remaining liquid or solid molecules. That disengaging of some of the molecules from the liquid or solid portion is the very act of creation of the vapor. That is, you cannot have vapor except as a separate entity from the liquid or the solid, so that in that sense of separation or liberation the act of creation or the vaporization itself is an act of separation, but that takes place whether or not the vapor is formed as a bubble within liquid or whether it takes place as a separation at a quiescent surface of liquid.

3085 1581 In this sense of molecular separation or liberation of vapors from liquid, separation or liberation occurs in defendant's cracking coil because vapors are formed in the stream of oil as it flows through the cracking coil, and as a bubble of vapor forms in that stream of oil you have this separation or liberation of that particular particle of vapor from the liquid portion of the oil.

3086 I don't recall ever having heard "separation" included as a necessary step or element of vaporization,

except as it has been spoken of in this case and in the case of the Universal Oil Products Company *vs.* Root Petroleum Company. Those are the only two occasions where I have heard it spoken of in that way.

Now, of course, the word "vaporization" often is applied to an operation where you do have both the vaporization itself and a separating or liberating step in the sense of segregation or passing off, but the vaporization refers to the formation step in that operation.

I most certainly never have ever heard among scientific or technical men that the generation or formation of vapors is not vaporization except in this case
3087 and the other case which I mentioned. That is, I never except in these two instances have heard it said that vapor formation was not vaporization.

I have read and understand the disclosure of the Dubbs patent 1,392,629 in suit.

3087/1582 On page 1 of the patent, beginning at line 9, it reads:

"This invention relates to improvements in processes of converting hydrocarbons and refers more particularly to an improved form of cracking process of the continuous type."

Now, that statement says, first of all, that it relates to improvements in processes of converting hydrocarbons. That would take in a rather large classification of operations. That is, we may convert hydrocarbons in various ways.

3088 Then it refers more particularly to an improved form of cracking process, that is one of these processes in which heavier hydrocarbons are cracked to make lighter hydrocarbons. That might be a process to make gasoline or kerosene, furnace oils, various lighter hydrocarbons from heavier hydrocarbons. And it says the process of the continuous type. Now, when we speak of a continuous type of process we do not mean a process which runs perpetually. We mean a process which feeds in raw materials continuously and takes out products continuously, and the raw materials in passing through the process are subjected to a series of treatments which bring about the desired result. In the process at any particular phase of the treatment, the treatment is uniform throughout

the length of the run. The process may be operated for a relatively short period, say a day or two, or it may be operated for many days, even months, but so long as it adheres to those general principles it would be classed as a continuous process.

3088 1583 The patent passes next to the objects of the
3089 invention, and in reading a patent I find that it is important to pay particular attention to the objects set forth because, in general, a patentee attempts to state in his objects what he believes to be the important contribution he is making to the art. The patent says first, beginning at line 13, page 1:

"Among the salient objects of the invention are to provide a process in which the oil is continuously fed through the cracking zone and thence through the vapor zone, and a portion of the generated vapors condensed and returned to the inlet side of the cracking zone for further treatment."

I think in explaining these objects it might be well to refer to the isometric chart so that we can point out where these objects are accomplished.

I might say that the patent drawings show a plan view and an elevation of the apparatus and it is a little bit difficult to follow from these two drawings, but an isometric drawing gives the impression of three dimensions and makes it much easier to follow that the patent drawings themselves.

3091 DX 772 differs from PX 509 in that DX 772 shows the tank L and the other appurtenances to that tank, which were omitted from the other. And it shows the outlet of the condensing coil G3 with just the valve H on it and broken off beyond that valve, which is the way the patent drawing show it, instead of showing the separator beyond the valve H. This exhibit 772 shows a diagrammatic representation of a furnace underneath the B tubes and another diagram-

3091 1584 matic representation of a furnace under the C tubes. The patent drawings show both sets of tubes encased in the furnace.

PX 509 shows a diagrammatic representation of a furnace under the B tubes only.

3092 Now, this first object says, "The oil is continuously fed through the cracking zone."

Now, it becomes clear a little later on that the crack-

ing zone comprises the B tubes and the C tubes together, so the oil is continuously fed through the cracking zone, that is the B tubes and the C tubes, thence through the vapor zone.

I take the vapor zone to mean the aerial system, which would include the vapor riser, pipes D, the inclined vapor pipes E, and the header G and the aerial condenser G'.

Then it says, "A portion of the generated vapors condensed and returned to the inlet side of the cracking zones for further treatment." That would be the portion of vapors which would condense in this aerial system and would run back through the pipe F and the pipe F', the valve H5, into the line J', and thence into the inlet of the B tubes. And that, you see, identifies the inlet of the B tubes as the inlet end of the cracking zone.

In the next object he says, "To provide a process of the character above referred to"—that is one in which we have established this cyclic operation—"in
3093 which the carbon containing residue is continuously removed from the cracking zone." The carbon containing residue is withdrawn f[illegible] the far end
3093.1585 of the C tubes. And there he defines the outlet end of his cracking zone as at this point where the carbon containing residue is withdrawn. He says it is withdrawn continuously.

Continuing, "while the reflux condensate is returned to the cracking zone for further treatment substantially free from carbon." That is, this reflux oil is returned continuously, and it is to be substantially free from carbon.

In the next object he says, "to provide a process which permits of the apparatus being operated for an extended period without the necessity of cleaning and in which that part of the system containing the precipated carbon, is free from subjection to any excessive heat."

Now, I regard that object as of especial significance and especial importance in this patent because we are dealing here with a continuous operation, and he says that this operation is to be permitted to operate for an extended period without the necessity of cleaning.

3094 Then he goes on to say how that is to be accomplished. He says, "and in which that part of the system containing the precipitated carbon, is free from subjection to any excessive heat."

Now, in other words, he is going to carry on a cracking operation of a degree of intensity which will form carbon and will precipitate carbon.

Now, in a process where the cracking is taking place in a part of the system which is subjected to a
3094 1586 strong heating, the formation and precipitation of carbon is an extremely dangerous thing. In fact if it is allowed to continue it would be a disastrous thing. So that in an operation where the cracking is so conducted that the carbon will be precipitated in a zone which is only mildly heated we have a solution of that carbon problem.

In this patent we have established a principle which permits that being done. I like to call that principal the fireless cooker principle. It used to be a popular method of cooking food to conduct the cooking opera-
3095 tion in what was known as a fireless cooker. This operation was carried out by heating the food up to an active cooking temperature and then transferring it over into a heavily insulated vessel where the heat was maintained and in which the cooking continued because of the maintenance of that heat for an extended period of time. Now, in those fireless cookers it was the practice to have some auxiliary plates which were heated separate from the food container and which were placed in the part of the insulated receiver where the vessel was contained, so as to supply some heat for bringing up the insulated vessel itself to the temperature and for taking care of heat losses. That is, while there was no fire applied to the food in the fireless cooker there was some small amount of auxiliary heat supplied through these hot plates which were inserted in the part of the vessel or part of the cooker which received the cooking vessel.

Now, we have that same sort of a system established in this patent, and the C tubes, which is the part where the carbon is to be precipitated, are not subjected to any excessive heat. The oil is heated up in the B tubes to the cracking temperature
3095 1587 and the cracking is initiated in there; but in this

3096 highly heated condition the oil is then transferred to these C tubes which are not excessively heated. In there the cracking continues because of this time factor effect which I discussed this morning and the cracking continues and is completed in those tubes, and cracking may be carried on to the point where carbon is formed and deposited in those tubes and it does no harm until it has accumulated to a point where the tubes would be excessively filled with carbon so that they could no longer act to hold a substantial quantity of oil.

That object, as I say, is a very important part of this patent.

Before passing to the next object I go back to the preceding one where it speaks of returning the reflux free from any substantial amount of carbon.

Carbon, of course, would mean the coke or carbon
3097 which is formed in these cracking operations if we carry them far enough, and we may presume, naturally, that if carbon is formed we also have these tars and asphaltenes which accompany the carbon, so that I would say that that means the reflux is to be returned substantially free of carbon and these tars and asphaltenes which would accompany the carbon.

The next object begins at line 31, "To provide a process in which the reflux condensate is continuously removed from the refluxing condensing apparatus and returned to the inlet side of the system."

3097 1588. That, I believe, adds the sense of continuity of removal of the reflux and return.

The next object beginning at line 35, "To provide a process in which the vapors not initially condensed are finally caused to pass through a single passage for a secondary condensing action."

That is, the vapors which pass through the aerial system and on up through this aerial condenser G' and are not condensed therein pass on over to the final condenser G3.

3098 He says, "and in general to provide an improved process and also a novel apparatus of the character referred to."

In other words, he considers that his apparatus is novel as well as the process.

I now summarize the information I derive from this patent from a statement of its objects and indi-

cate on DX 772 the apparatus provided for carrying out those objects.

In the first place he says he wants to establish this cycle in which the oil to be treated is fed through the cracking zone and through a vapor zone and part of the vapor is condensed and returned to the inlet side of the cracking zone. In the second place, he is to continuously withdraw the carbon containing residue.

In the third place the part of the system in which carbon will precipitate is not to be subjected to any excessive heat; in other words, the fireless cooker principle.

3098 1589 The other objects, I believe, can be said to comprise merely the thought of continuity of some of these operations and the final condensing of the desired product, and the thought that the apparatus itself is novel.

3099 I failed to point out where those objects are accomplished, but the first one is the cycle step in the B tubes and the C tubes, the cracking zone, the aerial pipes E, header G, air condenser G', as the vapor zone, and the return through the line F' to the inlet of the cracking zone. The carbon containing residue is withdrawn through line K regulated by the valve H'.

The C tubes are the zone which is not to be subjected to excessive heat, and that is the zone where carbon is to be precipitated.

A description of the operation which further throws light upon the objects which Dubbs seeks to achieve in this patent is to be found on page 1, beginning with line 71, which says:

"Describing the operation of the process, the material to be treated is drawn from any suitable source by means of the pump J and discharged therefrom

3100 through line J' into and through tubes B and during the time they are passing through said tubes, they are subjected to sufficient heat to cause the desired amount of cracking."

Now, that says that the oil is to be fed through this line J' and the B tubes by means of the pump J and that in the B tubes the oil is to receive its cracking heat, that is the heat to cause the desired amount of cracking. Now, it is significant that he does not

3100 1590 say where that heat is to act to bring about this cracking. He simply says that that heat is to cause the desired amount of cracking.

It will be quite apparent from the patent that that heat is to act in the B tubes and the C tubes.

"Said oil is then passed into the tubes C which are only partially filled with the oil and as the oil passes through these tubes, there is a liberation of vapors from same and which vapors pass up through the vapor tubes D, E and into header G and through aerial condenser G', through line G2, through water condenser G3 and discharged through pressure reg-
3101 ulating valve H."

Now, in that he says that the oil as it passes through these C tubes is going to liberate vapors. We might wonder why the oil would liberate vapors in passing through those C tubes if we were not acquainted with how this cracking reaction takes place, but when we consider that the oil enters these C tubes at the maximum temperature it has been heated in the B tubes to an active cracking temperature and is delivered to the C tubes at that cracking temperature and it flows along through these C tubes, naturally because of the temperature and the time factor working together there is cracking of the oil, and the light products formed by the cracking vaporize and liberate themselves from the liquid and pass on up into the aerial system through the pipes D.

You will note that there are four of these D pipes provided so that the vapors can escape from these tubes substantially as rapidly as they are formed there. It is provided with outlets for the vapors right along through these C tubes.

3101- 1591 Continuing with the operation, beginning at
3102 line 87, it says:

"The portion of vapors condensed while passing through vapor lines E, manifold G and aerial condenser G' are automatically drained back through these lines into drainage line F and from there through line F' enter into line J' and back into the heating tubes B."

Now, there he is establishing this cycle of reflux return through this aerial condensing system and run-back line F' and J' into the heating tubes. That is the thing that he describes in his first object.

The residue left in the coil C is drawn off through line K through pressure regulating valve H', to any suitable place.

Now, that is the thing that he sets up in his second object. That is the residue withdrawal. The carbon containing residue is withdrawn through this line K regulated by valve H'.

Then he says pressure is maintained on the entire apparatus and is regulated by the valve H. The valve H is over on the outlet of the final condenser, so that he is maintaining the pressure on the entire apparatus, and this pressure is to aid him in the cracking operation.

3103 Then in the next sentence he speaks of a pressure regulated by the valve H.

In the sentence beginning at line 93 the patent states:

"The residue left in the coils C is drawn off through line K through pressure regulating valve H, to any suitable place."

3103 1592 Then in the next sentence immediately he says:

"Pressure is maintained on the entire apparatus and is regulated by the valve H."

The second statement is the correct one. Of course the pressure is maintained and regulated by the valve H. And valve H', of course, is actually a liquid level control valve rather than a pressure control valve.

3104 I failed to point out here that he in describing the apparatus back at line 52 says that B are the cracking tubes and C are the vaporizing tubes.

Now, from that I understand that B are the cracking tubes because in those the cracking heat is applied to the oil and the cracking is initiated in there. C are the vaporizing tubes. The C tubes, of course, we find are maintained at the same pressure as the B tubes, and the oil is brought in there in a heated condition and the heat is conserved in there. The C tubes are larger in size. They are 10-inch tubes, as contrasted with 4-inch tubes, so that they will hold a larger quantity of oil, and in that way he provides time and temperature to continue and to complete the cracking reaction.

He identifies the cracking zone in the objects themselves, as I pointed out earlier, because he says that the reflux is returned to the inlet of the cracking zone
3105 and the carbon containing residue is withdrawn from the cracking zone. Now that automatically takes in

the B and the C tubes together as the cracking zone. But he divides his cracking zone into these two parts. The first part he calls the B tubes or the cracking tubes, or he calls them also the heating tubes,
3105 1593 and the second part he calls the vaporizing tubes or the C tubes.

Pressure conditions are uniform throughout the cracking zone because, as he says, the pressure is maintained on the entire apparatus and regulated by the valve H which is on the outlet of the final condenser. The pressure would necessarily be uniform throughout the cracking zone because he depends upon a gravity return for his reflux from the aerial system into the inlet of the cracking zone. Now, if there was any substantial difference in pressure between the C tubes and the B tubes the small amount of gravity head provided by that elevation of the aerial system would not be sufficient to overcome that difference and instead of the feed stock flowing into the inlet of the B tubes we would find that the feed would flow
3106 back up into the aerial system, so that the pressure conditions are necessarily uniform throughout the cracking zone.

The difference in size between the 10-inch C tubes and the 4-inch B tubes will not cause any lowering of pressure in the C tubes. The mere size of the container has nothing to do with the pressure in the container. You see that the B tubes and the C tubes are in open communication with each other through that pipe which connects them, and any difference in pressure between the B and the C tubes would be rapidly equalized through that pipe. In other words, if a pressure difference existed there of any substantial amount it would bring about a rapid flow of oil from the B tubes into the C tubes until that pressure was equalized.

3106 1594 It does not make any difference with respect to the pressure whether the vapors are separated or segregated from the liquid, in the sense that there is a layer of vapor above and liquid below, or whether or not the vapor is mixed up with the liquid.

3107 Mere mixing or lack of mixing has nothing whatever to do with the pressure conditions.

I think we could illustrate that again by the seltzer

bottle which I have used before. As we all know there is a pressure in the seltzer bottle while the vapor and the liquid are segregated from each other, and if we take the seltzer bottle and shake it up so as to mix the vapor and the liquid intimately together the pressure inside the bottle remains the same. It doesn't alter the pressure at all to either have the two mixed together or to have them separated.

Dubbs devotes the next paragraph on page 1 to the third object, relating to the part of his system where carbon is precipitated. That is beginning at line 99. He says:

"A light fire may be maintained under the tubes C as shown in the drawings or said tubes may be heavily insulated with cel-o-cel insulating material or any other well known insulating material to prevent loss of heat by radiation and thereby dispense with
3108 the fire under the tubes C."

There he identifies definitely the zone which is not to be subjected to any excessive heat, and that is the zone, of course, where he intends to precipitate his carbon.

Continuing with that paragraph he says:

3108 1595 "The level of the liquid in the tubes C is ascertained by trycocks H2, H3, H4 and the level controlled by valve H'."

There he tells us what the function of that valve H' is which he up here called a pressure regulating valve. That valve is used to regulate the level of the oil in the C tubes.

Continuing:

"The per cent of vapors generated from the oil as it passes through the tubes C will depend on the amount of heat acquired by said oil while passing through the 4" coils."

Now, in that he is telling us about this fireless cooker operation which because of the heat imparted to the oil in the B tubes and which is allowed to act for a period of time in the C tubes continues the
3109 cracking and produces the light materials, the gas and the gasoline, which then vaporize because of their volatile nature. Vapors are generated in there as the result of that cracking through the fireless cooker principle.

I think I had better explain how this preacquired heat can cause vaporization in the C tubes.

We might take water as an example of something which would not be chemically changed by heat. If we were pumping water through that system and heating it in the B tubes, if we got it hot enough under the pressure conditions existing in there the water would vaporize in the B tubes where the heat is being applied. Over in the C tubes when the water gets into that part of the system there is no increase in temperature there. There is no reduction of pres-
3109 1596 sure in there. Consequently no further vaporization of the water could take place, so that
3110 with water those C tubes couldn't act as vaporizing tubes.

With oil, on the other hand, we have this third factor entering into the vaporization, that is this factor of chemical change, cracking, which forms these lighter volatile products in the oil as it flows through the C tubes, and these lighter volatile products then, as they are formed, bring about the vaporization in there.

When these lighter products are formed or created by the cracking they find themselves under conditions of temperature and pressure at which they are normally vapor, and consequently they proceed to vaporize.

The last sentence on page 1 of the patent says that the percent of vapors generated from the oil as it passes through the tubes C will depend on the amount of heat acquired by said oil while passing through the 4-inch coils.

3111 I might say with regard to that sentence there that he says that the percent of vapors generated from the oil will depend on the amount of heat acquired by said oil while passing through the 4-inch coils. Now, I think it is necessarily implied there that he means the percent of vapors will depend upon that, other things being equal, because we can see that there would be other things which would influence the percent of vapors generated in there. For example, the rate of throughput would affect the percent of vapors generated in there, because a changing rate of throughput would change the length of time the oil

would remain in the C tubes, and that would affect the percent of vapors generated.

3111 1597 Obviously, also, a change in the level in the C tubes would affect the percent of vapors generated there, so that I think we have to read that sentence with the understanding that it is implied that other things being equal the percent depends upon the amount of heat acquired by the oil in the tubes B.

3112 On the next page in the illustrative run, which begins at line 35, he speaks of this same phenomenon. I might read that illustrative run. It says:

"Gas oil from mid-continent crude oil, such as Kansas, or Oklahoma, oils of 32 to 36 Baume gravity is taken and continuously supplied to the pump J and thence to the 4-inch coils B which are subjected to a temperature of 750 degrees to 860 degrees F. The heated oil then passes to the 10-inch coils C which are maintained about half full of oil and wherein vaporization takes place."

There he is speaking about this vaporization reaction which takes place because of the cracking which is carried out in the tubes C.

He has referred to that there in the last sentence on the first page where he says, "The percent of vapors generated from the oil as it passes through the tubes C will depend on the amount of heat acquired by said oil while passing through the 4-inch coils."

3113 In other words, the vapors generated there are going to depend upon the cracking, and the cracking is going to depend upon the amount of heat that is imparted to the oil in the B tubes. I think that passage which I read on page 2, line 43, where the word

3113 1598 "vaporization" occurs is the only place in the specification where the word "vaporization" is used.

In the specification Dubbs tell us that vaporization takes place in the C tubes; he tells us that these vapors are liberated from the oil as it passes through the C tubes; he tells us that the vapors pass out of the C tubes into the aerial system; he tells us that cracking takes place in the C tubes; that carbon is formed and deposited in the C tubes, and that carbon containing residue is withdrawn from the C tubes.

Of these things, Dubbs on page 2, line 41, where he

says, "The heated oil then passes to the 10-inch coils C
3114 which are maintained about half full of oil and wherein vaporization takes place". is referring there to this generation or formation of vapors which takes place in the C tubes as the result of cracking in there.

There is nothing in the Dubbs patent that indicates to me that in the word "vaporization" on page 2 he includes the liberation in the sense of segregation as well as the generation of vapors. I don't find anything in the patent which tells me that the patentee means anything for the word "vaporization" other than what it always has meant; that is the formation of vapors.

The Court: Let me ask right there, he says the vapors pass from these tubes. Doesn't that indicate that there was separation there before they passed?

The Witness: Yes. Yes, sir, very definitely there
3115 is separation of vapors in the C tubes. The separation follows the vaporization action itself.

3115 1599 The Court: I thought you were saying that there was nothing in the patent that indicated that there was any separation in the C tubes?

The Witness: I beg your pardon. I gave the wrong impression. I meant to say that there is nothing in the patent which indicates that Dubbs meant to include the separation step in the operation of vaporization. That is, to me this patent means that vaporization means just what it always has meant, namely the formation of vapors. It is true that separation does take place in these tubes in the sense of segregation and passing off, but there are also all those other things which take place in those tubes.

The Court: Well, I misunderstood you.

Mr. Von Holst: Q. You have, I think, already stated that the formation of vapors is described in the specification?

A. Yes, very definitely.

Q. In the C tubes?

A. Yes.

3116 Dubbs does not tell you in so many words that cracking takes place in the C tubes. He doesn't say that in words, that "I intend for cracking to take place in the C tubes," that is in words of that sort, but he does say it in words which are just as definite in his description of what does take place in there

and how the process is carried on, in that the oil is delivered to these tubes in the heated condition. That heat is conserved in those tubes. Those tubes are large in size so that they will hold a substantial
3116 1600 quantity of oil, and the pressure in the tubes
3117 is the same as the pressure in the B tubes. Now, those are conditions which necessarily and automatically bring about cracking in those tubes. You just can't help it. The generation of vapors in the C tubes also necessarily indicates cracking, because cracking is the only thing under those conditions which could bring about vapor generation in those tubes. The specification says that B are the cracking tubes, and it goes on to describe how the cracking heat is imparted to the oil in the B tubes. It doesn't tell you how much of the cracking actually takes place in the B tubes. Certainly the cracking is initiated in the B tubes, because we heated up to the cracking temperature in there, but I should say from the description of the apparatus and the operation that the amount of cracking in the B tubes would be small relative to the amount of cracking in the C tubes, for this reason, that the oil enters the B tubes in a rela-
3118 tively cool condition and it is heated in its passage through those tubes to the maximum temperature conditions, so that in a part of the tubes only is it at a cracking temperature.

Furthermore the B tubes are small in size relative to the C tubes, so that the time in the B tubes is relatively small. In the C tubes, on the other hand, the oil enters at its maximum temperature. There is a larger quantity of oil in the C tubes. The heat is conserved in there, so that the heat can act to bring about cracking, and accordingly I think it is quite definite that it is intended for the major part of the cracking to take place in the C tubes.

3118 1601 Dubbs doesn't say anything about vaporiza
tion in the B tubes in the specification. I do not find anything in the specification of the patent indicating that there is a generation of vapors in the B
3119 tubes. There is nothing on that point either way that I can find in the specification, as to whether generation is intended in the B tubes or whether it is not intended there.

I do find something in the claims about the physical

condition of the oil in the B tubes. The claims are all alike in respect to that point, that they all call for the heating operation to be conducted without substantial vaporization. For example, claim 1 reads:

"A process of converting relatively heavy into lighter hydrocarbons, consisting in passing a stream of oil through a zone where the oil is heated to a cracking temperature but without substantial vaporization."

In other words, the imparting of the cracking heat is to be done without substantial vaporization of the oil, and all of the other claims are alike in that respect. I do not find in the Dubbs patent a teaching that the unsubstantial vaporization permitted by the claims and occurring in the B tubes is not vaporization in the sense of the formation of vapor. There certainly is no statement to that effect nor anything
3120 hinting in that that vapor generation or vapor formation in an unsubstantial amount in the B tubes is not vaporization.

Considering just the cracking step itself in the light of the specification and claims, that is that limitation which I read from the claims. The patent teaches
3120 1602 that the cracking is to take place in a cracking zone which is divided into two parts, these two parts serving different functions. In the first part, that is in the B tubes, the cracking heat is imparted to the oil and the cracking is initiated. In the sec-
3121 ond part of the cracking zone, namely the C tubes or the vaporizing tubes, that cracking heat is permitted to act upon the oil for an extended period of time to accomplish substantial cracking, and that part of the cracking zone is not to be subjected to any excessive amount of heat. Accordingly the cracking which takes place in the second part of the cracking zone may be extensive cracking to the extent of forming and depositing carbon in substantial quantities with perfect safety to the operation.

There is no limitation stated upon the amount of vaporization in the C tubes. The vaporization would be determined by the operating conditions and how much cracking takes place in the C tubes.

We have this requirement in the claims, that the heating in the B tubes is to be accomplished without substantial vaporization. Now, that means with re-

spect to cracking that the cracking is not to proceed
3122 to a point which will bring about substantial vaporization in the B tubes.

3123 It is possible to conduct cracking in the B tubes but without substantial vaporization. Pressure is the agency for preventing vaporization, and by the use of pressure one may crack to a considerable degree without substantial vaporization. I am perhaps wearing out this seltzer bottle illustration but
3123 1603 I will use it once more. In the seltzer bottle we have water and carbon dioxide gas. Now, the
3124 carbon dioxide gas itself is a material which by itself would be liquid at the pressures in the seltzer bottle only at a temperature far below zero, far below zero Fahrenheit, but we know that in the seltzer bottle the water contains a substantial amount of carbon dioxide in the liquid form. It is dissolved in the water. The pressure and the solution effect of the water cause the carbon dioxide to be liquid therein at a temperature considerably above the temperature at which it would be liquid if it were by itself. In the same way, when an oil cracks the lighter products formed may be held in solution in the heavier hydrocarbons, be held there in liquid form by the application of pressure even at a temperature far above that at which the light materials would be liquid if they were by themselves.

I now compare the defendant's cracking conditions in its coil with the cracking operation which I have described as being taught in the specification of the Dubbs patent, having in mind the limitation in the claim.

3125 In the first place the defendant does not use this principle of the divided cracking zone, which is brought out in this patent and which I say illustrates this fireless cooker principle. In the defendant's operation the cracking takes place as the oil flows through a continuous coil of pipe located in a furnace where it is being actively heated throughout its length. The cracking which takes place as the oil flows through that coil brings about vaporiza-
3125 1604 tion of the oil to a considerable extent. In fact it vaporizes to such an extent that by the time it reaches the outlet of the coil 85 per cent by weight

of the oil is vaporized and the vapors occupy 95 per cent or more of the space in the tube. The vapors which are formed as the oil flows through the coil must pass on throughout the length of the coil. They cannot escape at an intermediate point and thereby escape the cracking reaction taking place in there.

In this divided cracking zone of the Dubbs patent the vapors which form in the C tubes may escape substantially as rapidly as they are formed, and con-
3126 sequently the cracking in the cracking zone of the Dubbs patent is essentially a cracking of liquid oil.

Q. Now this divided cracking step process of the Dubbs patent, what have you to say as to any advantage there may be in that in the cracking of different stocks?

A. That divided cracking principle, that fireless cooker principle, is an extremely important and valuable principle in an oil cracking process because that permits the process to be carried on in such a way that carbon may be formed in the operation without damage to the operation. Now, that affects the type of stock which may be cracked in this way, that to such an operation we may charge stocks which very readily form carbon and which when cracked form large quantities of carbon, and a process employing that principle may crack those stocks very advantageously.

3127 1605 Now the dirty stocks like topped crude and residual oil in the cracking operations may be obtained at a lower cost than the clean stocks which are required if one is to crack extensively without forming carbon. Consequently such a process can operate successfully and profitably upon stocks which could not be used successfully and profitably in a process which does not permit the formation of carbon.

A process which does not permit the formation of carbon is a coil cracking process, that is a process in which the cracking takes place within a coil which is being subjected to active heating throughout its length, because the formation of carbon in such a process would result in the deposition of carbon upon the heated surface in substantial quantities. This carbon would insulate the metal against the passage

of heat into the oil and the metal becomes overheated and weakened by excessive overheating, so that if it is continued the metal will fail and the operation will terminate in disastrous fire in many cases.

3128 Another thing about this fireless cooker principle, even in operations where a clean stock is charged, the cracking can be carried to a further point than it can in a process which does not permit the formation of carbon, because the clean stocks themselves can be cracked far enough so they will make quantities of carbon too, but the coil cracking process has to stop short of that point where carbon is formed in order to operate successfully.

3128 1606 The temperatures and pressures given in the illustrative run of the Dubbs patent permit of operating the process as I have described it. At the pressure given, which is approximately 100 pounds, I think one would have to keep the temperature within the lower part of the temperature range given, that is 750 to 860; and furthermore, I think it would be necessary in operating at the lower part of the temperature range to supply some mild heating to the

3129 C tubes, which is permissible under the teachings of the patent.

I base this opinion upon my experience over a number of years in operating oil cracking processes; in testing these operations for vaporization; and from the general observation which I can make resulting from that experience that one may have a wide latitude, a wide flexibility in these cracking operations because of the many factors which influence the operation and which make it extremely difficult to predict, without actually trying, just what can and what cannot be done.

I think at the low temperatures required at a pressure of approximately 100 pounds it would be necessary to operate with some mild heating of the C tubes to maintain the temperature therein in order to operate there successfully.

3130 As I interpret the patent, I do not think that Dubbs limits himself to the 100 pound pressure by any means. A hundred pound pressure is given in the illustrative run only, and even there it says a "pressure of approximately 100 pounds."

Dubbs indicates in the specification that he gives

himself latitude with respect to things that may be done without departing from the invention.

3130 1607 He says on page 2, at the top of the page:

"I do not wish to confine myself to the above described operation except as to illustrate the principle involved and which principle may be applicable in various arranged apparatus."

And he goes on after that to give an example of the sort of operation that he has in mind. He says:

"For instance, the reflux distillates may be returned to the heating coil B directly or"—

And parenthetically that is the operation that is described as tht direct return, and continuing—

3131 "or indirectly, part of them direct and part of them indirect. For instance, instead of returning the reflux condensate direct to the tubes marked B by means of line F', the same may be discharged into a tank marked L through line L' by opening the valve H^6 which otherwise would remain closed and closing the valve H^5 on line F' or part of the condensate may be returned directly back to the tube B through line F' by regulating the opening of valve H^5 and the rest discharged to tank L through line L' by regulating the opening of valve H^6. Tank L may be maintained under pressure or not and it may contain the raw material that is being treated or contain wholly the reflux distillate and from this tank the contents of same are fed to the tubes B through line M into pump J and from there discharged into line J'."

Now in that he gives an example of the latitude which he feels he should be allowed in his process with respect to this cycle of reflux return and he says that it would be still employing principles involved in his patent if you take the reflux out into a tank and there either keep it by itself or mix it with other feeds before it is returned. And you may keep the tank under pressure if you wish or have

3131 1608 it without pressure.

He continues there in respect to that to say, however,

3132 "It will be noted that the reflux condensate in all cases is trapped off from the vapor lines in such manner as to prevent their returning direct to the vaporizing tubes C."

In other words, the reflux may be returned to the cracking zone in a variety of ways but it is never permissible to return it direct to the C tubes without going through the B tubes. While he does not explain the reason for that it is apparent from this employment of the fireless cooker principle that if he returned his reflux direct to the tubes C he would have to impart a substantially larger amount of heat to the tubes C, and if he does that then he is in danger of trouble from coke deposition in those tubes.

He returns the reflux back through the cracking tubes, that is the B tubes, so that he may impart there the cracking heat and not have to impart that cracking heat in the C tubes.

3133 The reflux is cooled by the condensing action and that reflux must be heated back up again to the cracking temperature and the heat necessary for bringing it back to the cracking temperature would have to be imparted through the walls of the C tubes if the reflux were returned direct to the C tubes.

When the reflux is returned direct to the B tubes, when it gets into the C tubes with the charge it mixes with the residual oil. The reflux mixed with fresh feed comes through the B tubes, is heated therein, discharged into the C tubes and mixes there with whatever residual oil is left from the cracking of oil which preceded its entrance into the C tubes.

3134 1609 Pressure in the C tubes of Dubbs is necessary in order to carry on the cracking reaction which is desired to be conducted in there. Pressure in there permits the oil to be maintained at an active cracking temperature without vaporizing excessive quantities of the desired charging stock. In other words, pressure is the agency for having the desired cracking temperature in the C tubes. It serves to keep the oil in the liquid condition.

I think it is perfectly obvious that if it were desired merely to vaporize oil in the C tubes that the first thing one would do would be to reduce pressure in the C tubes because that, of course, would promote vaporization. But in this patent the C tubes being

3135 the second part of the cracking zone, it is desired that the vaporization which takes place in there shall be the result of the cracking which takes place in

there and accordingly pressure is required to accomplish that purpose.

If the oil is not held in the liquid condition in the C tubes, the oil will not crack under the conditions provided there.

The C tubes are provided with these vapor outlets which permit the vapors to escape substantially as rapidly as they are formed, and, consequently, we have to have pressure in there to maintain the oil in liquid condition in order to keep it in the tubes for the time necessary to bring about the cracking.

In his patent regarding the contents of the C tubes, Dubbs says on page 1 at line 78, in describing the operation:

3135 1610 "Said oil is then passed into the tubes C which are only partially filled with the oil"—

And he says also on page 1, at line 105:

"The level of the liquid in the tubes C is ascertained by try cocks H^2, H^3, H^4 and the level controlled by valve H'."

3136 And on page 2 he says, this is at line 40:

"The heated oil then passes to the 10-inch coils C which are maintained about half full of oil and wherein vaporization takes place."

Und . the conditions obtaining in the C tubes that I have described, the cracking which takes place therein is essentially the cracking of the liquid oil in there.

In the B tubes the pressure serves the same essential purpose that it does in the C tubes in that it keeps the oil in liquid condition in the B tubes.

The cracking in the B tubes would be liquid phase cracking because the oil is to be heated therein without substantial vaporization.

Q. Now within these limitations what would be
3137 the relative proportion of cracking between the B tubes and the C tubes of the Dubbs cracking zone?

A. Taking the pressure given in the illustrative run of approximately 100 pounds, very little of the cracking could take place in the B tubes without bringing about substantial vaporization, so that under those conditions substantially all of the cracking would have to take place in the C tubes.

By the use of higher pressure, however, one could increase the proportion of cracking which would take

place in the B tubes. But in any event a very
3137 1611 substantial proportion of the cracking must take place in the C tubes because this cycle of vaporization, reflux condensation, and reflux return, which is an important part of this patent, requires that vapors be formed, that is that we must have vaporization in order to make the vapors for completing the cycle, and since that vaporization is reserved to the C tubes we must have enough cracking in the C tubes to accomplish the vaporization for carrying on the
3138 process. Therefore, in any event we must have a large part of the cracking taking place in the C tubes.

You could not within the Dubbs patent specification, as I have interpreted it, do substantially all the cracking in the B tubes and substantially none in the C tubes, without departing from the principles of the Dubbs invention for the reason that I just stated. That is, the first object of the patent sets up this cycle of vaporization, reflux condensation and reflux return, and if we did all of, or substantially all of the cracking in the B tubes then that cracking which is to take place in there without substantial vaporization would mean that we then would have no place for vaporization to take place because the vaporization in the C tubes takes place as the result of the cracking in the C tubes, and without cracking in the C tubes we could not get this vaporization which is necessary for carrying out this object of the patent.

3139 The time factor is not taught in words in the Dubbs patent. However, I think it is inherent in the description of the apparatus and the process in that it shows the B tubes to be smaller in size, four inches in diameter, the C tubes are large in size, 10 inches in diameter, the C tubes therefore will hold a larger amount of oil and consequently the oil in
3139 1612 there will be subjected to the cracking conditions for a longer time. Furthermore; in the B tubes the temperature is being raised throughout their length by the application of heat, so that the cracking temperature, the maximum cracking temperature is reached just at the outlet and a portion of these tubes, at least, is not at a cracking temperature at all. Only part of the B tubes are at a cracking temperature, whereas all the C tubes are at a crack-

ing temperature. So that the time factor, the major part of the time factor is supplied in the C tubes.

There is no indication in the Dubbs patent as to
3140 how much vaporization is permitted by the phrase "without substantial vaporization." That phrase appears only in the claims and there is no explanation of what is meant by or how much is covered by "without substantial" and "with substantial".

The specification in another connection uses the word "substantially" on page 1 in the objects where it says, beginning at line 19:

"to provide a process of the character above referred to in which the carbon containing residue is continuously removed from the cracking zone while the reflux condensate is returned to the cracking zone for further treatment substantially free from carbon."

The word "substantially" is used in the claims in respect to things other than vaporization. It is also used in the claims with respect to this reflux return. For example, in claim 1, beginning in the middle of the claim at line 76, it says:

"removing the residue, after said vaporization, from the system without permitting intermingling of any substantial portion thereof with the oil in the heating zone."

3141 1613 The same appears in claim 2.

And in claim 3 we have "substantially" used in connection with the continuity of residue withdrawal where it says:

"Withdrawing substantially continuously the residue from said chamber"—

This particular use of the word "substantial" that I have referred to, does not give any quantitative evaluation on the question which I say is not stated specifically in the Dubbs patent as to how much vaporization is permitted in the phrase "without substantial vaporization" with respect to the heating of the oil in the B tubes.

3142 But it seems to me that what would constitute insubstantial vaporization would reasonably apply to the intermingling of an insubstantial portion of residue with reflux. In any event, I think that the word restricts the amount of vaporization and the amount of residue return or carbon return to a small amount.

My views of how much vaporization is tolerated by the phrase "without substantial vaporization" are that it would be limited to a few per cents, perhaps two or three, maybe as much as five per cent by weight.

3143 There is nothing in the Dubbs patent to indicate that that teaching that the oil should be heated without substantial vaporization in the B tubes permits of substantial formation or generation of the vapors in the heating step. That requirement means that substantial formation of vapors, that is vaporization, is not to be permitted in the heating step.

Q. Assuming that the word "vaporization"
3143 1614 means here a mere separation or liberation of vapors from the liquid surface, that is segregation, or that the word vaporization includes as a necessary element this segregating step, what would be the result as applied to conditions in the B tubes of the Dubbs patent?

A. In the first place there is nothing in the patent to indicate what desirable or undesirable effect would
3144 result from the application of such a meaning to the word "vaporization", and the operation which might result therefrom. It seems to me that if one were to give that sort of a meaning to the word "vaporization" we are left completely in the dark as to how this heating operation should be conducted.

Let me illustrate what I mean by that, in an example. Let us suppose that the oil is fed into the tubes. Of course it is fed in in a liquid condition, and it is heated as it progresses through the tubes. Now if that is heated sufficiently under a particular set of pressure conditions, it will commence to form vapors, but if those vapors remain mixed up with the liquid, that is if there was sufficient velocity there to keep the liquid from segregating into the lower part of the tube, and the vapor into the upper part of the tube, then giving "vaporization" this special meaning we would not have vaporization. We might have, let's say, 50 per cent of the oil converted into vapor, maintained, mixed up with the liquid, and by this special definition of "vaporization", that would not constitute
3145 vaporization. Well, we can assume conditions where we would have 75 per cent, or we might still have

them all mixed up so that with our special definition of "vaporization," there would be no vaporization.

3145 1615 Let us vaporize more, let us go up to 90 per cent and on up to 95 per cent, 98, 99 per cent, if we keep the vapor and the liquid all mixed up together then by our special definition we still do not have any vaporization, we simply have vapor formation but no vaporization.

Let us keep on, let us go to 99, exentually get up to 100 per cent, we could keep all the material, liquid material mixed up with vapor all the way up to that until the last particle of liquid vaporized.

Now nowhere in there have we separated that vapor from the liquid, so by this special definition of "vaporization" nowhere have we had vaporization; and yet we have the whole thing in vapor form. That sort of definition leads to that kind of an absurdity, and there is no teaching in this patent to

3146 throw any light on how to clear that matter up.

Q. What have you to say as to the use of the word "substantial" in the phrase "Bringing the oil to a cracking temperature but without substantial vaporization", if the word "vaporization" means either the step of separating vapors from a liquid surface or includes that separating step as a necessary element in the meaning of the word "vaporization"?

A. Well, we are in difficulty there also in the application of the word "substantial" to that sort of a condition. Now I can visualize a condition where vapors would be formed in the tube and the vapor and liquid would be flowing along slow enough so that the liquid would segregate to the bottom of the tube and the vapor would segregate to the top of the tube.

On the other hand, the velocity may be suffi-

3146 1616 ciently high that the liquid and the vapor would be all mixed up together.

Now if we give this peculiar meaning to "vaporization" then the first condition, I should think, would

3147 be called "vaporization", that is we have the separation or segregation there.

The second condition would be a lack of vaporization, would be no vaporization.

Now somewhere in between those two conditions

would have to be substantial vaporization and somewhere would be insubstantial vaporization. Just what the condition of insubstantial vaporization would be, or what the condition of substantial vaporization would be, I have not the slightest idea and I do not get any help from the patent on that point.

Assuming that if the oil traveling through the B tubes were in a foam it would be no substantial vaporization, but that if it were traveling through the liquid, were going through as a spray carried by the stream of vapor there would be substantial vaporization, I do not find any teaching in the Dubbs patent that would either sustain such a distinction or throw any light on it.

The words "foam" and "spray" do not appear in the patent anywhere. There is no teaching in the patent in regard to what conditions would constitute
3148 a foam or what conditions would constitute a spray.

The phrase "without substantial vaporization" does not teach me anything about velocity of the oil in the B tubes of the Dubbs patent.

I don't believe the word "velocity" appears in the patent either. "Without substantial vaporiza-
3148 1617 tion" would indicate right away to me pressure because pressure is the thing which is used to prevent vaporazition. That would be a teaching of enough pressure to prevent substantial vaporization rather than velocity. Pressure is taught in the patent.

If a vapor bubble forms in a body of liquid contained in a vessel with a vapor space above the surface of the liquid it rises to the surface because of the action of gravity. The gravity acts on the liquid more strongly than it does on the vapor, consequently the liquid forces the vapor to rise—the vapor bubbles to rise to the surface.

3149 Q. Does heat have any effect upon separation or segregation in the sense of a bubble rising to the surface and escaping or being liberated or segregated?

A. It may have this effect, if one were dealing with a viscous liquid. For example, take molasses which is respesentative of a viscous liquid, a bubble rises slowly in molasses because of the viscosity of the fluid. Now if we heat the molasses the viscosity decreases

and a bubble would then rise at a faster rate; but in dealing with oil cracking and the separation of a bubble from a body of hot oil, the viscosities of the oil at these cracking temperatures are so low that any effect of changing the temperature on the rate at which the bubble would rise, is utterly negligible, and accordingly I would say that in connection with the oil cracking process the effect of temperature upon the separation is negligible.

3150 The only possible effect that pressure could have upon the separation of the bubble would be in
3150 1618 compressing the vapor so that it is more dense, and hence more nearly the specific gravity of the liquid, but again at the pressure conditions in these cracking processes, that is approximately 100 pounds given in the illustrative run of the Dubbs patent, and the pressure used in the defendant's operation, the difference in specific gravity of the liquid and of the vapor is so great that we may say that the action of pressure in either accelerating or retarding the separation, is negligible.

So that in this oil cracking art, when we say that pressure is used to prevent vaporization, we mean that pressure is used to prevent the formation of vapors.

And in this oil cracking art when we say temperature is used to cause vaporization, increase of temperature is used to cause vaporization, we mean the temperature is used to form the vapor from a liquid.

3151 Q. Now, what conditions would prevent a separation of vapors and liquid in the sense of a segregation into a layer of liquid below and vapors above?

A. Segregation takes place, as I said, because of the action of gravity upon the two materials, gravity acting more strongly upon the liquid. To overcome that action we have to agitate or mix up the two in some way. For instance, the bottle half full of water, we mix the two by shaking the bottle, agitate it, stir it up. If we stop the shaking, the agitation, then the two immediately segregate, separate in the sense of segregation.

In a flowing stream in which we may have the two phases, vapor and liquid, we have to have agitation there in order to keep the two from separating, and

the agitation is promoted by the velocity or flow
3151 1619 of the materials through the pipe, that is at a high velocity there is a stirring or mixing action
3152 which throws the liquid to the upper part of the flowing stream and it may submerge the vapors in the lower part of it.

I do not find any teaching in the Dubbs patent that the flow of oil in the B tubes is to be turbulent enough to prevent this segregation of the stream in the vapor above and the liquid below. There is not any teaching of velocity or turbulence or agitation in the patent with respect to what takes place in the B tubes.

The disclosure in the specification of the Dubbs patent as to the cleanliness of the reflux returned to the inlet of the heating tubes B is covered in the objects on page 1, beginning at line 19:

"to provide a process of the character above referred to in which the carbon containing residue is continuously removed from the cracking zone while the reflux condensate is returned to the cracking zone for further treatment substantially free from carbon."

3153 That indicates that the patent permits the contamination of the reflux by some insubstantial amount of carbon, and of course we naturally include the tars and asphaltines, which would normally accompany carbon in a cracking process. That would permit of some contamination by entrainment, for example, if any residue entrained up with the vapors into the D tubes, the aerial system, a small amount of that would be perfectly permissible. Or if there was some vapor phase cracking in the D tubes in the early part of the aerial system, that contamination would be perfectly all right. It would even permit the return of some small amount of the residue itself,
3153 1620 the part that is taken out from the C tubes. As a matter of fact the type of process taught here, this two-stage fireless cooker principle in the cracking zone, makes the process of a nature that will tolerate dirty materials being fed to it. That is one of the big advantages to it. You may feed topped crude or
3154 even feed the cracked residue from some other operation to it, and it would handle it with satisfactory results because the later stages of that cracking, the

important part of the cracking, takes place over in the C tubes where it is not subjected to any excessive heat and where carbon can form and deposit without doing and harm.

I now refer to page 1 of the Dubbs patent, lines 52 and 53: "B are the cracking tubes. C are the vaporizing tubes." This passage does not indicate to me that Dubbs used the word "vaporization" to indicate the separation or segregation of vapors from liquid. The meaning of that passage becomes perfectly clear with a study of the process itself. B are the cracking tubes because in B the cracking heat is imparted to the oil and the cracking is initiated. That is what he means by "B are the cracking tubes".

C are the vaporizing tubes because in those the cracking continues and vaporization occurs as the
3155 result of the cracking. B and C tubes make up the cracking zone.

Q. Now on page 1, lines 77 to 84, it is stated, and I have to read two passages here:

"Said oil is then passed into the tubes C which are only partially filled with the oil and as the oil passes through these tubes, there is a liberation of vapors from same and which vapors pass up through the vapor tubes D, E and into header G."

3155 1621 And also on page 1, lines 108 to 112:

"The per cent of vapors generated from the oil as it passes through the tubes C will depend on the amount of heat acquired by said oil while passing through the four inch coils."

Now state whether or not in these two passages there is anything that indicates to you by the word "vaporization", as used in the Dubbs patent, that the patentee means either the separation or segregation of liquid from vapor, or that the word "vaporization" as used by Dubbs necessarily includes this separating or segregating step?

A. The second passage there refers to the operation of vaporization, that is the vapors generate in there, vapors form; that is vaporization. The first passage, that may mean where it speaks of "libera-
3156 tion" there, it may have one of two meanings there. If "liberation" there is used in the sense of segregation, that is the segregation of the vapor in the upper part of the tube and the liquid in the lower part

of the tube, then that passage refers to the operation which is subsequent to the vaporization.

If the patentee uses "liberation" there in the sense of this molecular transformation from a liquid state into a vapor state, which occurs when the bubble is formed, then in that case the liberation or the bubble formation is the vaporization, of course; the same thing.

3158 1622 I now refer to Plaintiff's Exhibit 501, a certified copy of the file wrapper and contents of the Dubbs patent in suit, and to the original claims, 1 and 2 of which say: "Passing the oil through a heating coil in a cracking zone, passing the oil and generated vapors into a vapor chamber."

That says nothing about the quantity of generated vapors referred to. It might mean either a small or a large amount of generated vapors.

3159 The phrase "generated vapors" in these original claims does not indicate to me that in the patent as filed there is a teaching that oil and vapors in the heating coil were intimately mixed in the condition of a foamy mass. There is nothing there about any degree of mixing or foam or foamy mass or anything of that sort.

The patent as originally filed uses the expression "generated vapors", on page 1 in the first object, where it says:

"Among the salient objects of the invention are to provide a process in which the oil is continuously fed through the cracking zone and thence through the vapor zone and a portion of the generated vapors condensed and returned to the inlet side of the cracking zone for further treatment."

Now of course the "generated vapors" referred to there are the vapors after they have passed out of the C tubes and are up in the aerial system, and it is

3159 1623 those generated vapors which are condensed and returned to the inlet side of the cracking

3160 zone. So at that point he is applying the same "generated vapors" to vapors which have completely passed up and away from the liquid. In other words, they are separated in the sense of having passed off from the C tubes.

And I suppose if we are going to be technical about the thing, we would say that he indicates that "gen-

erated vapors" indicate rather separated vapors than vapors intimately mixed, from that use of the word.

Referring to the Dubbs patent in suit as issued, and to claim 1, the phrase "removing the residue after said vaporization," referring to the vaporization in the C tubes, does not mean removing the residue after vapors are both formed and separated from the liquid oil in the C tubes.

I don't think that includes the separating step in the sense of a segregation which takes place in those tubes. The residue takes its form when the vapor
3161 forms. That is, when the vapor is created the characteristics of the residue are determined at that time; that is, it becomes residue as the vapor is created.

Q. Now referring to the defendant's separator and assuming either of the definitions of vaporization as given by plaintiff, either that it means purely separation in the sense of segregation or that that is a necessary element of vaporization, does the defendant in the separator withdraw residue after vaporization?

3161 1624 A. In the defendant's vapor separator there is a foamy or frothy mass of liquid extending for a number of feet up into the separator. This is brought about by the high velocity of the stream of material entering the vapor separator which enters very close to the bottom of the separator, and this serves to agitate and stir up this small amount of liquid in there into this foamy mass.

Now if "vaporization" includes the separating step, or if "vaporization" is the separating step, that takes place up in the vapor separator some distance
3162 from the bottom, and the residue, however, is drawn off from the bottom very near where the stream enters the separator.

Now if vaporization does not take place until you get up here in the upper portion of the separator, above the foam or froth, then it seems to me that you would necessarily conclude that residue is withdrawn before vaporization because the residue is withdrawn from the bottom very near the inlet. Now that does not make sense to me but that is what I am led to if I include the separating step as a necessary part of the vaporization or if I say that vaporization is the separating step.

In claim 5 of the patent as issued the phrase "affording a vaporization space above the stream during the second stage of the travel thereof to said discharge point" seems a rather odd use of the word "vaporization" as an adjective modifying the noun "space". That by itself would certainly excite
3162 1625 my curiosity, but as I read on in that claim, the
3163 next passage, he says: "taking off the vapors from said vapor space."

There he clears up what he means by that; he says that is a vapor space.

In these two passages, the vaporization space is the same as the vapor space.

He says "The said vapor space" referring to what he has up above called the "vaporization space."

I might add to that, that words are used rather loosely in this patent in a number of cases. We find that the grammar might be corrected in places, and the spelling might be corrected. I don't mean to say that in criticism of the patent at all because I feel that this patent is perfectly clear and understandable, it is to me, but I simply mention that we do find words used in a rather odd way in a number of places in the patent.

3164 If reflux is diverted out into tank L, which is the alternative method shown in the specification, one would probably lose some heat from the reflux and that reflux would have to be replaced by additional harder firing of the B tubes. It, of course, involves also the use of additional apparatus and additional pumping costs to get the oil, to put this heat back in because with the other operation it runs in by gravity and there is no cost attached to the return in that way.

The advantage in returning the reflux direct to the
3164 1626 inlet of the heating tubes as compared with a once-through process where the reflux might be collected in a tank and returned to the coil on a subsequent occasion, either alone or mixed with the
3165 fresh feed, is that the immediate return of reflux gives this advantage of heat conservation and the advantage of the use of less equipment and less pumping costs. Those are the only advantages I can see which attach to that.

The idea has been advanced that this reflux being

a cracked product is an excellent solvent for cracked or tarry materials themselves, and thereby aids in keeping these materials in solution and carrying them out of the heating coils.

Now if one is charging a dirty stock to the process then the reflux being a cleaner material serves to dilute the dirty constituents of the dirty stock and helps to carry them along. I do not think there is any doubt about that. But if on the other hand one is charging a clean stock to the process, then we have
3166 no such solution effect acting at all. That is best evidenced by the fact that one may take a clean gas oil stock and crack it without admixture with reflux to a greater extent without forming or depositing carbon than one can with that same fresh stock mixed with its reflux.

For example, one might take a gas oil and put it through a cracking operation and crack once through to make 30 per cent of gasoline, or even more, even a higher percentage of gasoline, without forming or depositing carbon.

Now if one takes that same gas oil and mixes
3166 1627 it with reflux and puts it through the cracking operation, then one would develop carbon and deposit carbon in the process with that same conversion or a lower conversion to gasoline.

The thought also has been advanced that the return of reflux in the Dubbs process serves to keep the reactive molecules separated so that the polymerization reaction is retarded and tied up with the fact that the polymerization reaction is a second order reaction; namely, that it involves the bringing to-
3167 gether of two or more molecules, uniting them, and that if one separates those reactive molecules by mixing some other material in, then there is less chance for the reactive molecules to get together and to polymerize.

Now the difficulty with that as applied to this refluxing operation is that the materials which polymerize are the unsaturated materials formed in the cracking reaction, and the reflux itself is loaded with these unsaturated materials, these reactive materials which will polymerize. In fact reflux may be polymerized to tar at temperatures well below those at which it cracks.

For example, one can take a reflux and keep it heated to a temperature of, say, 600 degrees for a period of time and polymerization will go on in that quite actively. That temperature, of course, is below the temperature at which the reflux cracks, still it would develop tars by being heated at that temperature for a period of time. Of course at a higher temperature, that is getting the reflux up into
3167 1628 the cracking temperatures, the polymerization reaction goes on at a faster rate. So that the
3168 return of reflux mixed with the fresh feed, instead of retarding this polymerization reaction actually promotes polymerization reaction because the reflux itself polymerizes.

There is an advantage in reflux return in Dubbs in that it permits a low cracking per pass with a high yield. The basic reason for returning reflux in any cracking operation is that we find we cannot convert in one cracking all of the available cracking stock into the desired products. We get gasoline, we get some gas, and we get tars and carbon, but there is always some material left which is suitable for additional cracking and which can be put back into the cracking operation to make more gasoline. And that is why reflux is returned in any of these cracking operations.

Now the same thing applies in the operation described in this patent.

3169 When I come to consider this Egloff patent I find myself in a different situation from that when I studied the Dubbs patent, because to me the Dubbs patent teaches a useful process and a useful principle in cracking. This Egloff patent, on the other hand, is very meager in its disclosure and I do not find in this patent where a useful process is taught.

The objects of the patent are found on page 1, beginning at line 9, which reads:

3169 1629 "This invention relates to improvements in process and apparatus for cracking oil, and refers more particularly to a process in which the oil is distilled under heat and pressure, certain of the vapors subjected to reflux condensation and subjected to further cracking."

Now there he identifies the type of process with which he is dealing. It is one of these pressure distillation processes.

A pressure distillation process is a process similar
3170 to the Burton or the Burton-Clarke process in which the oil is heated in a large tank or container equipped with vapor outlets so that the vapors can escape substantially as rapidly as they are formed, and in which the oil is heated, cracked and distilled, under pressure, the purpose of the pressure being to hold the oil in a liquid condition so that a cracking temperature may be maintained on the oil.

I have had experience with pressure distillation processes. I have had quite a few years experience with the Jenkins cracking process, which I mentioned yesterday, which was used extensively by the Skelly Oil Company and that is one of these pressure distillation types of processes.

Returning to the patent and continuing that quotation there, at line 15, he states the object and says:

"the object in the present instance being to subject the reflux condensate to different conditions of temperature or pressure or both than that to which the raw oil is subjected."

That is his first object and I have searched this
3171 patent through to find out what useful purpose
3171 1630 is attained by that object, and it is not stated in the patent anywhere and I am unable to state any useful purpose for it myself in a pressure distillation type of cracking operation.

He says, continuing:

"Another object of the invention is to, if desired, subject part of the apparatus to vacuum action."

Quite a little of this patent is devoted to this matter of subjecting part of the apparatus to vacuum action, but there again there is no explanation of what useful purpose is attained in subjecting any part of the cracking apparatus to vacuum action, and I don't know of any useful purpose which is attained by doing that. Those are the only objects which are given in the patent.

Referring now to the drawing of the patent and briefly tracing the cycle, I read what the patent says about that, beginning at line 26, it says:

"Referring to the drawings, 1 designates a furnace, provided with combustion chambers 2 and 3, separated preferably by a foraminated bridge wall inside."

That would be this bridge wall which is marked 4.

3172 "In the respective combustion chambers are mounted the heating coils 5 and 6, each of which may take the form of a continuous length of several hundred feet of two to 8-inch pipe. The lower coil 5 is connected by feed line 7 to charging pump 8, leading to any suitable source of raw oil supply, as for example fuel oil or heavy asphaltic crudes such as California or Mexican crudes containing in themselves little gasoline, or the like."

Now in that he is saying that this process could be used to charge a dirty type of stock.

3172 1631 "The delivery side of the coil 5 is connected by transfer line 9, having throttle valve 10 and pressure gage 11, to the end of an elongated horizontally disposed expansion chamber 12. This expansion chamber may for example be 68 inches in diameter and 40 to 60 feet long. It is located outside the fire zone and suitably supported above the furnace by means of supports 13."

In that he says that the expansion chamber is not to be subjected to any external heating operation.

And continuing:

"The delivery side of the coil 6 is connected by
3173 auxiliary transfer line 14, having throttle valve 15 and pressure gage 16 to the main transfer line 9. The expansion chamber 12 is provided with residue draw off pipe 17, having throttle valve 18, and with a vapor outlet pipe 19, having throttle valve 20, leading to the lower side of the dephlegmator 21."

Now I might explain there that that vapor line is shown broken off there just to bring the apparatus closer together. And likewise the dephlegmator is shortened up, showing a break in that. The actual dephlegmator would be, was intended to be higher than is shown there.

"The dephlegmator 21 is provided with a series of baffle like plates 22",

Those are inside here (indicating).

"and at its lower side is connected to reflux return line 23, having throttle valve 24, and leading to reflux oil pump 25 interposed in the feed line 26, leading to the
3174 inlet side of the heating coil 6. The upper end of the

dephlegmator is connected by vapor line 27, hav-
3174 1632 ing throttle valve 28, to the top of condenser coil
29, seated in condenser box 30. The lower end of the coil 29 is connected by pipe 31, having throttle valve 32, to the upper part of receiver 33. This receiver 33 has liquid level gage 34,"—

That is the glass on the outside there.

"pressure gage 35, liquid drawoff pipe 36, controlled by valve 37. It is also provided with two gas outlet pipes 38 and 39, controlled by throttle valves 40 and 41, respectively. The pipe 39 is connected to a vacuum pump 42,"

This explains this vacuum operation—

"whereby a vacuum may be maintained on the receiver, condenser, dephlegmator and vapor chamber, or on the receiver alone or receiver and condenser alone, or receiver, condenser and dephlegmator alone. This is accomplished by suitably regulating the various valves shown."

That is, these throttle valves on the pipes connected with the various units.

"The dephlegmator is provided with pressure gage 43"—

That is up on the top there.

3175 "and the vapor chamber with pressure gage 44."

3176 Pressure may be regulated at various places in this apparatus. It may be regulated by the throttle valve 40 on the gas outlet pipe of the receiver. In that event all of the valves on the various pipes connecting the apparatus up to that point would be open and the pressure would be maintained and regulated by that.

Or it might be regulated by the valve 32, which
3176 1633 is on the line between the condenser and this receiver, and in that case the valves in the lines ahead of that would be open. Or it might be regulated by valve 28 in the vapor pipe coming out of the top of the dephlegmator. Or it might be regulated by valve 20 on the pipe leading from the expansion chamber to the dephlegmator. Or it might be regulated by the valves 15 and 10 in the outlets of the coils 5 and 6 so as to operate the expansion chamber and all of the subsequent equipment under a low pressure or vacuum.

The oil cycle through there is described in the next
3177 part of the patent, beginning at line 85, where it says:

"The process may be carried out as follows:

"Fuel oil, as for example fuel oil from the Wayside Kansas field of say 25 degrees Baume;"

That would be a topped crude, I believe, what we now call a topped crude generally from this Kansas production, that is a crude oil which had had the lighter fractions distilled off of it, leaving just the heavier residual fractions.

Continuing,

"may be heated to a temperature of say 700 degrees F., and subjected to a pressure of say 135 pounds in the heating coil 5, and delivered in substantially liquid phase through the insulated transfer line 9 to the expansion chamber 12."

That temperature is a cracking temperature; that is, we generally say that 700 degrees represents the low end of the cracking temperature range in
3177 1634 commercial operations, but that temperature brings about cracking at such a slow rate that it is not suitable for a coil cracking operation at all. In other words, passing the oil through a coil and heat-
3178 ing it only to 700 degrees would not bring about any cracking. To crack it at 700 degrees you have to get the oil in an apparatus where it can be held at that temperature for hours and hours at a time, apparatus like the Burton or the Burton-Clark still, for example.

He says that the oil is delivered in substantially liquid phase through the insulated transfer line 9 to the expansion chamber 12. That means that the heating which is accomplished in the coil is not to cause the oil to vaporize to any substantial extent. It is rather curious,—he mentions that transfer line 9 is insulated but he does not say anything about the expansion chamber itself. We just have to presume that he means to insulate that too.

Continuing:

"This expansion chamber may be maintained under a pressure of say 135 pounds."

Now 135 pounds pressure is a pressure which is suitable for carrying on these pressure distillation types of operation. The pressure distillation operations have been carried on commercially from pres-

3179 sures of around 75 pounds up to, oh, several hundred pounds, 300, 350, 400 pounds; so that a pressure of 135 pounds is a pressure which is suitable for a pressure distilling operation.

Continuing:

"The reflux condensate may be pumped back
3179 1635 by pump 25 to the heating coil 6, and there subjected to a pressure of 175 pounds and a temperature of say 770 degrees F. It is delivered in substantially liquid phase to the vapor chamber 12."

Now he says that the reflux is to be heated to this higher temperature of 770 degrees, and it is heated under a higher pressure of, say, 175 pounds. Again, 770 degrees is a cracking temperature but it is not a cracking temperature which is suitable for cracking oil in a coil. It is a temperature which still requires a long time to bring about substantial cracking and you just don't get that long time in passing the oil through a coil. You have to hold the oil in some container which will hold a lot of oil in order to get substantial cracking.

It provides such a chamber, the large expansion chamber is the type of thing you use for cracking at
3180 that sort of a temperature. He does not give you the temperature in the expansion chamber.

He does say that the oil from both of these coils is to be delivered to this expansion chamber in substantially liquid phase, that is the oil is to be heated but it is to be substantially in a liquid condition when it gets into the expansion chamber.

The expansion chamber is clearly not intended to be heated externally, so it has to get whatever heat it receives from the self-contained heat of the oil coming into the expansion chamber. That self-contained heat acting for a period of time, if it is high enough and if the time is long enough, would bring about some cracking of the oil, and if the cracking is sufficient
3180 1636 under the conditions prevalent there, the pres-
3181 sure conditions, it would bring about some vaporization as the result of cracking. The cracking and vaporizing operations require some heat; that is, they absorb some heat and if any substantial amount of the cracking and vaporization takes place in there we would find the temperature decreasing in the unheated tank of this sort.

These temperature and pressure conditions in Egloff would bring about cracking in the expansion chamber if there was some means of maintaining those temperatures for an extended period of time. Of course, the mixed stream entering the expansion chamber would be at some temperature intermediate between the 770 of coil 6 and 700 of the coil 5. Just what that temperature would be would depend upon the relative amounts of the two streams.

But the difficulty that we encounter in attempting to operate this in this way would be that in order to get reflux to go through coil 6 you have to get vapor-
3182 ization in expansion chamber 12; and in order to get vaporization in expansion chamber 12 you would have to have cracking in there and that requires temperature and time, and in order to get a cracking temperature in there you have to have reflux because that stream is the one which is heated to the higher temperature. So that you are up against the difficulty of getting heat to bring about the cracking, to bring about vaporization, so that you can get reflux to get heat. It works in a sort of vicious cycle there for which there doesn't seem to be any solution.

3182 1637 That is true even though the expansion chamber be insulated, that applies in any case. The vaporization in the expansion chamber of Egloff is the result of any cracking which takes place in the expansion chamber and the formation of the light materials which would vaporize under those conditions.

That is the same proposition which takes place in
3183 the C tubes of the Dubbs patent. That is, the lighter materials formed by the cracking, when they are formed they find themselves under temperature and pressure conditions at which they would be vapor, so they vaporize as they form.

The statement of the condition in which the oil is to be delivered to the expansion chamber has a bearing as to what is to cause vaporization in the expansion chamber. I think that clearly indicates that the patentee had in mind that he was going to deliver this liquid oil into the expansion chamber and have that liquid oil crack in the expansion chamber and form vapors as a result of the cracking.

Q. Now disregarding the statement in the Egloff

patent that the invention refers particularly to a process in which the oil is distilled under heat and pressure, is there any teaching in this patent of a process where the oil is cracked in the coil?

A. Well, continuing with the reading of the pat-
3184 ent— It says, line 103 on page 1:

"It will be thus seen that the reflux condensate is continuously subjected to a re-cracking, but at different conditions of temperature or pressure, or both, than that to which the raw oil is subjected."

3184 1638 Now it says, it is continuously subjected to re-cracking and he means that the re-cracking to take place in this coil 6. Of course, re-cracking means that it is a cracking following a cracking; and that cracking which is meant there is the cracking which is intended to take place in this expansion chamber. It is to crack first in the expansion chamber and then the reflux is intended to be re-cracked in the coil, in coil 6.

The Court: Q. Would there be cracking in the expansion chamber again?

3185 A. Yes, our Honor, it would then continue to crack in the expansion chamber providing the conditions suitable for cracking in there are maintained. The difficulty with this is that, while he says the oil is to be subjected to re-cracking in this coil 6, he does not provide enough temperature to accomplish any substantial amount of cracking in the coil; just too low a temperature, 770 degrees would not do it.

In the process which I say Egloff teaches, there would be no advantage in separately heating the raw oil and the condensate.

I do not see where there would be any advantage in separately heating the raw oil and the reflux in that type of operation where the cracking is to take place in the expansion chamber, this big vessel there. The reflux might just as well be mixed with the fresh charge, as in Dubbs, and the two heated together.

I do not see where there would be any advantage
3185 1639 in heating the two separately and then mixing them and then putting them in the tank to crack. The patent does not give any clue as to what advantage is expected to be gained by that.

3186 There is a little more to this specification here

which describes his ideas about the vacuum operation, continuing where I left off there at line 107, he says:

"A process may be carried out in the apparatus in the manner just above described, except that the dephelgmator, condenser and receiver, instead of being under a pressure of 135 pounds as in the first case, may be subjected to a vacuum through suitably regulating the vacuum pump, opening valve 41, closing the valve 40, and regulating the valve 20, valves 28 and 32 being also open."

Again he does not give any idea as to what useful purpose would be served by that. The specification does not say how much oil is maintained in the expansion chamber.

Q. Do the claims say anything about how much oil is there?

A. Well, claim 1, take claim 1 as an example. It says

"A process of oil conversion, consisting in maintaining a body of heated hydrocarbons in an enlarged zone where substantial vaporization occurs."

Now obviously the enlarged zone would be the ex-
3187 pansion 12, and maintaining a body of heated hydrocarbons would mean maintaining a substantial amount of oil in there, I should say.

Q. Referring again to the specification, and having in mind that teaching of the claim that the body of oil is maintained in the chamber, what have you to say as to the relative dimensions of the coil and chamber as being consistent or inconsistent with
3187 1640 the teaching that it is a pressure distilling operation?

A. Well, the size of the expansion chamber which he gives, that is 68 inches in diameter and 40 to 60 feet long, that of course is a pretty good sized vessel and would hold quite a lot of oil. The coils he described as being several hundred feet of 2 to 8-inch pipe. Well, the coil would contain a smaller amount of oil particularly if the smaller sizes of coils were used. I do not recall ever hearing of a cracking coil being built of pipe as large as 8 inches. Generally they use the smaller sizes of pipe in a coil that is to be used in a cracking process.

3188 As described in this illustration here, which is the

process description of the patent, conditions are not provided which would bring about commercial yields of gasoline.

I don't believe the word "vaporization" is used in the specification but it is used throughout the claims.

The phrase in claim 5, line 94

"and simultaneously heating an independent stream of charging oil for delivery to said enlarged zone to a temperature sufficient to cause a substantial vaporization thereof in said zone,"

means to put enough heat into the oil so that when it gets over into the expansion chamber vaporization would take place. Of course, in that description the vaporization would take place as the result of cracking in the expansion chamber.

Vaporization caused by heat is simply vaporiza-
3189 tion; the formation of vapor is caused by heat.

3189 1641 Q. As you understand this Egloff patent, would it be within its teaching to reduce the pressure on the expansion chamber?

A description of the apparatus mentions the possibility of reducing or of subjecting the expansion chamber to a vacuum action. However, in the description of the process there is no mention of the vacuum action being applied to the expansion chamber.

A process which is to be of the pressure distilling type necessarily would have to maintain enough pressure on the expansion chamber so as to permit cracking temperatures to be maintained in the expansion chamber.

Under those conditions the cracking of the oil, if any should occur in the Egloff expansion chamber, would be cracking in the liquid phase. And the vapors are free to pass out through the vapor lines substantially as rapidly as they are formed and they would not be held in the expansion chamber long
3190 enough to accomplish substantial cracking.

If any re-cracking occurs in coil 6, that would be also in the liquid phase because he says the oil is to be delivered from that coil to the expansion chamber in liquid phase.

This partial pressure effect in the distillation of hydrocarbon oils is a technical subject which is rather hard to understand. I think Dr. Cady made a very

good explanation of that. But it seems to me that what we are really concerned with is the effects of the partial pressure action and these may be briefly stated as follows:

3190 1642 That in the vaporization of mixed materials, that is materials having a range of boiling points such as we have in these oils, the vaporization takes place at a temperature intermediate of the boiling temperatures of the constituents if those constituents were being heated at the same pressure but were 3191 by themselves; that is, the temperature at which vaporization would take place would be above the boiling temperature of the lower boiling constitutents and below the boiling temperature of the higher boiling constituents.

Now when vaporization takes place you have vaporization not only of the lower boiling constitutes but also vaporization of the higher boiling constituents which are existent in the mixtufe, and the vapors themselves are mixtures of the constituents of the liquid being subjected to vaporization. The vapors, however, contain a larger percentage of the lower boiling constituents than the liquid contains, and the vapors contain a lower percentage of the higher boiling constituents than the liquid contains.

What we mean in explaining that phenomenon by the words "partial pressure" is that in the liquid the various constituents are exerting a vapor pressure and the total vapor pressure exerted by the mixture is the summation of the individual pressures of 3192 the various constituents, and these individual pressures are called the partial pressures. This partial pressure effect is the reason why the dephelg- 3192 1643 mating step in the cracking process is necessary that partial pressure effect makes necessary these dephlegmating operations because the vapors which form in the cracking operation are not made up of the desired low boiling constituents alone, but they also contain higher boiling constituents which should be additionally cracked in order to get maximum yields. And the higher boiling constituents have to be separated from the lower boiling constituents, and that separation is carried out in this dephelgmating operation.

I am familiar with the cracking operation of defendant, Globe Oil & Refining Company, as conducted
3193 at its Lemont plant. I was present and took part in the inspection of the plant which was the basis for the stipulated operation in this case, the inspection took place in 1933.

I have had prepared a chart (DX 774A) illustrating in a simplified manner the apparatus and process of the stipulated operation.

3195 DX 775 is a photograph of the Winkler-Koch plant of the Globe Oil & Refining Company at Lemont, Illinois.

These identifications that are put upon this photograph where it says "Exchanger, vapor separator, atmospheric distillation flash tower", have been checked by me and are accurate.

3196 Referring to the chart, DX 774A, I divide the process therein illustrated as follows: There is a red line on this chart which divides the process into two parts in accordance with my interpretation of the operation, in that the part to the left of the red line is the cracking operation of the process and the part to the right of the red line constitutes the sep-
3196 1644 arating steps and the steps for distilling the fresh charge to prepare a suitable cracking stock for the operation.

To the left of the chart DX 774 we see isometric representations of the two furnaces. The upper furnace is called the low pressure furnace. That is used for heating the fresh charge, which is the topped crude oil. The lower furnace is designated a high
3197 pressure furnace and that is the furnace in which the cracking operation is carried on.

To the right of the furnaces appears the vapor separator, which is a cylindrical vessel 8 feet 6 inches in diameter by 41 feet 3 inches high.

On to the right of that again is the bubble tower which is also 8 feet 6 inches in diameter and it is 59 feet 7 inches high.

On to the right of the bubble tower is shown a diagrammatic representation of the condenser for condensing the desired light products. Actually the condenser is made up a a great many feet of pipe submerged in water inside of a large box. It is merely a diagrammatic representation.

Below the condenser is shown the gas separator. There are some other parts of the apparatus shown on here. For instance the hot oil pump is shown
3198 immediately below the bubble tower, and we have some other pumps here, a naphtha pump for charging heavy naphtha and a reflux pump for regulating the temperature in the bubble tower.

That particular pump that I have marked C,
3198 1645 on DX 774 pumps some of the condensed light products back to the top of the bubble tower simply for the purpose of regulating the temperature in the bubble tower. That has nothing to do with returning the reflux to the cracking coil. The reflux is returned to the cracking coil by the hot oil pump which is marked A on this drawing.

I will just trace the oil cycle briefly for a moment on DX 774 starting with the charging stock for the cracking coil which is taken from the bottom of the bubble tower by the hot oil pump marked A and delivered to the high pressure furnace where it passes through some 5800 feet of pipe which is 3 inches
3199 inside diameter by 4 inches outside diameter, the walls of the pipe being a half inch thick.

The cracked products leave the high pressure furnace and enter the vapor separator where the cracked tar is separated out from the vapors and the cracked tar is withdrawn through the line shown, leaving the bottom of the vapor separator, passing out through a cooler to a storage tank not shown, through the line which is marked "Fuel Oil, 1620 barrels per day, 10.1 degrees API." The vapors pass out of the top of the vapor separator through the vapor line, and this vapor line is shown broken there because in the actual apparatus there are some heat exchangers located in that vapor line which merely serve to extract some heat from these vapors for aiding in the preliminary distillation of the crude oil. They serve no function in the cracking operation itself. I omitted them for the sake of simplicity.

3199 1646 These vapors then enter the bubble tower and in there they are subjected to a cooling action which causes the heavier constituents of the vapor, that is the gas oil, to condense back to a liquid, and
3200 this liquid gas oil collects at the bottom of the bubble tower to be picked up by the hot oil pump.

The vapors which are not condensed in the bubble tower and which make up the fixed gas and the desired product pass out through the condenser into the gas separator, in which the uncondensed gas is separated from the liquid condensate, and the gas passes out through the pipe leaving the top of the gas separator through the line marked "Wet Gas 100,000 pounds per day," and the desired product, the desired liquid product, is drawn off from the bottom of the gas separator through the line which is marked "Pressure Distillate 2224 barrels per day, 54.6 degrees API, 1860 barrels per day gasoline content."

There is some additional oil fed into the cracking furnace which is introduced into the discharge line from the hot oil pump A. This is a heavy naphtha which is composed largely of gasoline fractions and which is fed through the process in order to improve the anti-knock properties of those gasoline fractions.

Some gas oil is withdrawn from the process through
3201 the line which goes off to the right of the suction line for the hot oil pump to the cooler and beyond the valve where the line is marked "Gas oil 160 barrels per day, 22.2 degrees API."

The fresh charge for the process is a reduced
3201 1647 crude which is fed in through the low pressure furnace. This reduced crude represents about 50 per cent of the crude oil which the plant operates on. That is, the crude oil has had about 50 per cent distilled off in a topping, so-called topping operation, taking off the gasoline and kerosene fractions.

That reduced crude is fed through this low pressure furnace where it is heated up to 720 degrees and delivered into the transfer line from the high pressure furnace just before it enters the vapor separator, and in the vapor separator then this reduced crude is vaporized to a considerable extent and the vapors which are clean gas oil vapors pass out of the top of the vapor separator mixed with the vapors from the cracking operation.

Those clean gas oil vapors from the reduced crude
3202 make up the charging stock for the high pressure furnace. They replace the part of the charging stock which has been converted into tar and the desired product, fixed gas. They keep this charge replenished.

This high pressure furnace is divided into several banks of tubes. The furnace itself contains a large combustion chamber where the fuel, which may be gas or fuel oil, is burned, and these gases then from the burning of the fuel pass upward in this large combustion chamber and flow over a dividing wall which is called a bridge wall. Those gases flow over that wall and then down through several banks of tubes located behind the bridge wall. The gases make a U-turn up over this bridge wall and flow down through these banks of tubes.

3202 1648 After passing through those banks of tubes they are collected into a duct or flue and pass out at the left-hand end of the furnace, on out to the stack.

The oil enters the lowest row of these tubes in these
3203 banks of tubes behind the bridge wall. Of course there the oil first contacts the gases which are the coolest because the gases have been giving up their heat as they flowed from the fire over the bridge wall and down through these tubes, so that the gases are in their coolest condition at that point where they first meet the fresh oil.

The oil enters the furnace at a temperature of approximately 600 degrees, a little under 600 degrees, flows through a bank of six rows of tubes in the bottom part of this what we call convection section of this furnace. The convection section is the part of the furnace back of this bridge wall.

After flowing through these six rows of tubes it is brought out through a connecting pipe or a cross-over pipe, as we call it. It comes out of there at a temperature of 665 degrees.

I failed to point out that the arrangement of these tubes in this furnace is such that when the oil comes in instead of entering just one tube the stream divides and enters two tubes in parallel and flows through
3204 those two tubes to the opposite end where those two tubes are connected to two adjacent tubes by a header, so that the two streams come together in the header and then they divide once more and pass back through two other tubes in parallel, and the flow through the furnace is that way throughout.

3204 1649 That is the two streams flowing in parallel tubes come together in the header at the ends of

the tubes, and then the stream divides again and goes through two other parallel tubes, uniting and dividing that way all the way through. That is a convenience for holding down the pressure drop occasioned by the rapid flow of the oil through the furnace.

The actual length of tubing in this line is about 5600 feet of 4-inch tubing. The oil travels, of course, just half that distance because it is dividing all the way along, and any portion of the oil travels half the total length of the tubing, that is 2800 feet.

3205 After passing through this first bank of tubes, which we generally call an economizer bank because its purpose is principally to sort of strip the heat out of these hot gases, and these contact, the coolest gases with the coolest oil, and thereby extract the maximum of heat out of the gases, so it is an economizer bank. Then the oil passes up into the next to the top row of the convection bank and it flows through that next to the top row and then comes up and flows back through the top row of the convection bank. Of course there it meets very hot gases because the gases have just come from the fire right over the bridge wall, and it is heated in those two rows of tubes up to a temperature of 725 degrees.

Now, at that point it is at a cracking temperature but there has not been enough time for any cracking to take place at that point, so that the oil is still in the condition in which it entered the furnace except that its temperature has been increased.

3205 1650 It passes from these two top rows of the convection bank into the lower row of the so-called roof bank.

3206 Now these two rows of tubes in the roof bank are located just as though they were arranged across the ceiling of a large room, and they extended out over this combustion chamber, so that the tubes are exposed to the direct radiation from the fires burning down here in the combustion chamber. Of course there is a lot of hot brick work in this combustion chamber, making up the walls, and that radiates heat to these tubes also, so that we get a high degree of heating in these roof tubes because of their location.

It passes through the lower row of roof tubes clear across the furnace and then steps up into the upper

row of roof tubes and back across the furnace once more, and issues from the furnace at the opposite end. Then it drops down to one of these crossover pipes into the third from the top row in the convection bank and flows then in a crosswise and downwardly direction through the remaining tubes of the convection bank.

It leaves the roof tubes at a temperature of 910 degrees Fahrenheit. There was no cracking had taken place when the oil entered the roof tubes but by the time it has passed through the roof tubes and has been additionally heated it has been cracked to a substan-
3207 tial extent, and the cracking has resulted in a certain amount of vaporization. You will find about 10 per cent by weight of the oil has been vaporized at that point, and the vapors, of course, occupy a larger volume than the liquid from which they are formed, occupy about 30 per cent of the space in the tubes.

3207 1651 Now, the oil continues to crack as it is additionally heated in the remaining banks of tubes, comes out of the tubes at a temperature of 940 degrees Fahrenheit, in other words it has been heated additionally 30 degrees so that it is now at a temperature of 940 degrees, and the cracking and the vaporization, of course, have been going on at a rapid rate while it is passing through those tubes due to the high temperature in there.

We find at that point that approximately 85 per cent by weight of the oil has been vaporized and the vapors formed occupy about 95 per cent of the space in the tubes. As to whether these vapors formed in the defendant's cracking furnace are separated from the liquid, we have to make sure in just what
3208 sense we are using this word "separation". If we mean by "separation" the segregation or stratification of liquid into a lower layer and vapor into an upper layer we don't have separation of that sort. On the other hand, the vapor, when it forms in the stream of oil, there forming first as a bubble, of course that bubble no matter how small it is separates from the liquid. That is, it becomes a separate material. Regardless of whether it is mixed up with the liquid or whether it rises to the top of the surface when it becomes a bubble, it becomes separated from

the liquid, and in that sense, of course, we do have separation in those tubes.

The determination of the amount of material vaporized in that was made by actual test or inspection. We attached an apparatus on the transfer line for measuring or determining the vaporization, and
3208 1652 measured the actual amount of vaporization which had occurred up to that point.

3209 There is no difference in the vaporization which occurs at the point where the arrow points to the transfer line on DX 774 and the outlet of the furnace, immediate outlet of the furnace. The stream is moving at a very rapid rate by the time it reaches that point and the vaporization which is measured in the transfer line would be the same as the vaporization in the final passage through the tubes there, so that that actually represents the condition at the outlet of the furnace itself.

From my experience in the oil cracking business the furnace structure and the method of heating tube arrangement in that cracking furnace is quite important to the success of the process because, as I pointed out yesterday, in a process where the cracking is taking place in the part of the apparatus where the heat is being actively supplied to it we have to be very careful to avoid the formation of carbon, and carbon may be formed by what we call
3210 local overheating. That is, by local overheating, I think an illustration of that would be if we take a pan of milk and put it on the stove and heat it too fast, it burns or carbonizes on the bottom. That is what we mean by local overheating. An oil will act to a considerable extent the same way, so we have to be careful not only to avoid carrying the cracking too far so we get to the stage of carbon or coke formation, but we have to be careful also how we apply the heat so that we don't locally overheat the oil before it reaches that point. And this furnace is designed to take care of that condition so as to get the maximum usefulness out of the opera-
3210 1653 tion, that is to be able to carry the cracking as far as it is safe to without getting into coke formation.

Part of that provision resides in this large combustion chamber that is supplied here. That permits

the fuel to be consumed, the flames to be dissipated before they have a chance to come in contact with the tubes themselves, because the flame is much hotter than the gases and if the flame plays directly
3211 on the tube, why, we put the heat in so fast we are in danger of local overheating.

The recirculation of flue gases is another provision which takes care of this regulation of the heating operation and at the same time aids in establishing the capacity of the furnace. The recirculation of flue gases means that some of the gases which have passed down through the convection bank and have collected in the flue, some of those gases are picked up by a fan and discharged right back into the combustion chamber.

Now, that seems like a rather odd expedient, offhand, to put the gases which have already been cooled back in and make them go through the cycle again, but it has this effect, that the cooler gases mix with the very hot gases from the flame and that reduces the temperature of the hot gases. At the same time it heats up the cool gases and we then have a larger volume of gases at a temperature which is below the temperature of the hot gases from
3212 the flame and above the temperature of the gases which were returned. It is like mixing hot and cold water to get warm water. You get a larger volume of warm water than either the hot or the cold.
3212 1654 That larger volume of tempered gases entering it does not put the heat in quite as fast where it first gives up its heat to the tubes because it is at a lower temperature, but being larger in volume as it flows down through these convection banks here it washes over those tubes at a higher velocity, and at its higher velocity it scrubs out the heat better, so that we get more of the heat down in through the convection bank.

The charging stock that goes to defendant's cracking coil comes first of all from the bottom of the bubble tower. It was collected in that bubble tower as the result of the dephlegmating action on the vapors coming over from the vapor separator. In other words, the charging stock is the condensate
3213 from these vapors. It has no residual materials in it.

The gravity of that stock is shown here in con-

nection with the portion which is drawn off to storage, shown to be 22.2 degrees API. It is clean stock because it has been distilled, it has been vaporized and brought over here and condensed. That is mixed with a small amount of this heavy naphtha. The naphtha makes up such a small proportion of the total charge that it does not alter the characteristics of the charge to any great extent.

We find that the mixed charge has a gravity of 23.1 degrees API, which is very nearly the same as the gas oil from the bottom of the bubble tower itself.

I don't believe I did explain that this gas oil from the bottom of the bubble tower is actually made up of two constituents namely the insufficiently
3213 1655 cracked oil which has already been through the cracking furnace but was not converted in passing through, and the gas oil which was vaporized out of the topped crude which was fed into the vapor separator.

3214 This gas oil, this 22.2 degree gas oil, contains those two materials, made up of those two.

In the low temperature, low pressure furnace we charge a topped crude, and in the high temperature, high pressure furnace we are charging a clean gas oil stock. The reason for that distinction is that the topped crude would not be suitable for charging to this high pressure furnace and for subjection to the conditions prevailing in there because the topped crude contains so much of this dirty asphaltic material that if it were cracked to the extent that the oil is cracked in the high pressure furnace it would very quickly fill up some of the tubes with coke and our operation would have to be shut down.

If topped crude were fed to this cracking furnace, then to operate it successfully we would either have to operate with a very short run or we would have to alter the conditions so that we would not crack nearly so much of the material into gasoline.

3215 This stream as it leaves the high pressure furnace contains around 27 per cent of gasoline.

That cracking furnace would not tolerate a dirty stock such as the residuum drawn off from the vapor separator in those conditions.

The same thing would be true about the residuum

which is true about the topped crude. To put
3215 1656 that back and to subject the oil to the cracking conditions which prevail in that cracking furnace would bring about coke formation which would immediately plug up the operation and cause it to shut down.

The meaning of that phrase "pressure distillate" on DX 774 is this: the early commercial cracking operations for making gasoline were of this pressure distilling type which I mentioned a while ago. That is the Burton and Burton-Clark type of operator, and the product from that operation came to be known as pressure distillate because it was produced in this pressure distilling operation. The name came
3216 to be applied generally to the raw cracked material from a cracking operation regardless of the type of process in which it was produced. It is just a common name which is used in the oil cracking industry to designate the raw cracked product from the cracking operation.

Cracking starts before vaporization starts in this cracking furnace. By the time the oil leaves the roof tubes we find that we only have 10 per cent by weight of the oil vaporized, and at that point the stream contains, I believe, about 9 per cent of gasoline.

Now, the stream of oil would develop something on the order of 6 or 7 per cent of gasoline before its vapor pressure would be built up sufficiently to start vaporization under the pressure conditions existent in that furnace. The pressure used there is this 660 pounds at the inlet and 500 pounds at the outlet, and the pressure in the roof tubes would be
3217 some intermediate pressure, perhaps 600 pounds.
3217 1657 and under that pressure and that temperature that oil has to develop something like 6 or 7 per cent of gasoline before it starts to vaporize. Prior to that time the lighter ends formed are in a liquid condition. They are in solution in the liquid stream.

As vaporization proceeds in that defendant's coil we have vaporization of the light products formed by the cracking, and of course that vaporization is accompanied by vaporization of some of the heavier products due to this partial pressure effect. The

vapors are a mixture of the light products and the heavier constituents of the stream.

The vaporization in the defendant's coil increases the velocity of the travel of the oil through the coil. It increases, first of all, due to the expansion of the oil itself, due to the rise in temperature before any vaporization starts. That expansion is relatively small so that it only brings about a relatively small
3218 increase in velocity, but when vaporization starts then the velocity starts increasing at a much more rapid rate.

Entering the furnace the oil is traveling at a velocity of a little under six feet a second, about 5.7 feet. It increases to a little over six feet a second in passing through the first bank and is increased to about 6.6 feet a second by the time it leaves the second bank, that is the two rows of tubes at the top of the convection bank.

3218 1658 At the outlet of the roof tubes, due to the fact that the vaporization has started, the velocity has increased to about 10 feet a second, and it keeps on accelerating as it goes through the remaining portion of the convection bank, reaching a velocity of something in excess of 20 feet per second by the time it leaves that bank.

As vaporization proceeds in defendant's coil the vapors thus formed remain mixed up with the stream
3219 of oil due to the agitation which is imparted by the velocity of the flow in there, so that the vapors and liquid move along together and the vapors, consequently, are subjected to the same cracking conditions of temperature and time as the liquid is subjected to.

The cracking in the defendant's furnace is liquid phase cracking and it is also vapor phase cracking due to the fact that, as I say, the vapors have to travel along through the entire length of the coil. They are subjected to the same conditions to which the liquid is subjected, so that actually it is a mixed phase cracking operation.

In defendant's cracking process pressure does not serve the same purpose as in a pressure distilling operation. In a pressure distilling operation pressure serves the purpose of keeping the oil liquid so that it can be cracked in the liquid condition, because in a pressure distilling operation when the vapors

are formed they can escape right out of the
3220 1659 cracking container, and they therefore are not subjected to the cracking conditions.

In this type of an operation, however, the defendant's type of an operation, the vapors cannot escape from the cracking zone independent of the liquid. They are subjected to the same conditions and the pressure in that case serves the purpose of squeezing these vapors into a smaller volume so that we can have more oil in the coil under treatment.

The oil remains in the defendant's coil something like five and one-half minutes altogether. In the first two banks where there is no cracking it requires about two and one-half minutes to pass through, and in the roof tubes where cracking starts it takes about two minutes to go through there, and then through the remaining tubes down to the convection bank which takes about an additional minute, so that the oil is actually undergoing cracking for about three
3221 minutes.

3221 1660 First of all the carbon problem is dealt with in defendant's cracking furnace by limiting the conversion or the cracking to a point short of that at which carbon begins to form. In other words, the polymerization reaction goes to the stage of forming these asphaltenes and tars but it is terminated before the tars have a chance to go on down into coke.

In the second place, the heating conditions are carefully regulated there so that we avoid the carbon formation and local overheating of the oil. Of course the stock charged to the furnace is a very important element in that consideration of coke formation. By using a clean stock for charging to the furnace the defendant is able to get a degree of cracking in that furnace which it does get, whereas if you used a dirty
3222 stock you would have to be satisfied with a much lower degree of cracking.

I will now take up the operation of DX 774 beyond the pressure reducing valve B, and will you describe what takes place in that vapor separator and beyond.

The cracking operation takes place in this high pressure furnace, the cracking furnace. After the oil gets out of that then the object is to stop the cracking and separate the products. Now the cracking is stopped in two ways. In the first place we have this

pressure regulating valve B here on the transfer line coming out of the high pressure furnace, and the pressure is reduced through that valve from 500 pounds down to a pressure of 26 pounds, which exists in the vapor separator. Now, that reduction in
3222 1661 pressure, of course, causes a great expansion of the vapors in the oil and brings about additional vaporization of the oil, and this expansion or vaporization causes some cooling of the stream, also because it takes heat to vaporize and to expand vapors,
3223 so that the very operation of reducing the pressure at the same time reduces the temperature somewhat.

However, that temperature reduction accomplished by the reduction in pressure is not enough to stop the cracking in that stream and further temperature reduction is brought about by the introduction of this topped crude into the stream at that point. The topped crude is at a temperature of 720 degrees and the stream coming out of the furnace here is at a temperature of 940 degrees before pressure reduction, and pressure reduction would probably drop it down 25 to 50 degrees below that.

The topped crude then mixing with this hot stream further reduces the temperature to about 800 degrees, 805, in fact, at the bottom of the vapor separator.

Now, it may seem rather odd that we would undertake to cool a hot stream of material by heating the cooling material up to 720 degrees, that we could cool more effectively by taking the stock at atmospheric temperature, but this topped crude serves a dual purpose. It not only cools this stream to stop the crack-
3224 ing but it also supplies the charging stock to the process by having the clean gas oil stock vaporized out of it.

Now, if we used the topped crude at the tem-
3224 1662 perature at which it leaves the topping or reducing operation, that is 540 degrees, of course it would take a smaller amount of the topped crude to effect the necessary cooling, and by having a smaller amount of topped crude you wouldn't get enough gas oil to keep the process running. So the topped crude, instead of being fed in at 540 degrees is heated up to 720 degrees. Then, of course, it takes more topped crude to effect the same amount of cooling and we get more topped crude into the system and thereby get

more charging stock into the system, and we can keep the process running.

The mixture of topped crude and the hot stream from the cracking furnace contains vapors and contains residual liquid, tars, aphaltenes from the cracking operation, and the heavy tarry asphaltic material out of the topped crude, and in the vapor separator
3225 this mixture of residual products is separated out from the vapors and is drawn off through the pipe at the bottom of the vapor separator, through the cooler, and goes out to storage, and that makes up this fuel oil of 10.1 degrees API gravity.

The function of the vapor separator with respect to the topped crude is to bring about this distillation of the clean gas oil stock out of the topped crude. Now, in this distillation operation which takes place at a temperature of about 800 degrees, that is a cracking temperature, of course, and there is some incidental cracking of that topped crude at that temper-
3225 1663 ature. We get some gasoline and some gas, and also we get the formation of some gas oil by the incidental cracking of the very heavy constituents of the topped crude. That effect is shown here in the block to the left of the vapor separator which shows 105 barrels per day gasoline, 20 barrels per day P. D. bottoms, 120 barrels per day gas oil and 6,000 pounds per day of gas produced in the vapor separator by cracking, that is the incidental cracking of the topped
3226 crude which takes place which accompanies the distillation of that topped crude to recover the gas oil charging stock.

It is not necessary to the defendant's operation that that gas oil charging stock should be prepared as it is. That is simply a convenient and economic way of preparing that gas oil charging stock. Similar operations prepare the gas oil charging stock in some separate operation in the refinery and feed that gas oil as a liquid directly to the bubble tower. But by doing it in this way there is an economy effected in the distillation because you use some of the heat which has to be removed from the cracked stream anyhow. That has to be cooled to carry on the operation. You use that excess heat for carrying on the distillation of the topped crude, and then, of course, in addition it simplifies the apparatus required, because to pre-

pare the gas oil charging stock in some outside operation would require the use of a still for heating the oil, either a shell still or pipe still, and a means for separating the vapors and condensing them and
3227 1664 collecting them in storage, and so on. It would require much more apparatus and require additional expense to produce it in that way.

Nevertheless many times these cracking operations of this sort do use a separate operation.

I am familiar with the separate operation of preparing a clean stock by distillation. The operations carried on at the Skelly Oil Company refinery which I was in charge of, used that method to a considerable extent.

In that separate distillation operation there was incidental cracking accompanying the distillation. That is characteristic of these simple distillation operations when topped crude is distilled to produce a suitable gas oil charging stock for cracking. The gas oil is of the boiling range such that considerable portions of it boil below the cracking temperature, but some portions of it boil above the cracking temperature, and consequently it is necessary to heat the reduced crude up to a cracking temperature in order to distill all the gas oil out of it. Consequently in
3228 these simple distillation operations it is characteristic to have this incidental cracking with the formation of a small amount of gasoline and gas and some gas oil from heavier products, just as it occurs in this operation here.

The gasoline formed in this way represents some 2-1/2 per cent of he topped crude that is fed into the apparatus, and that small amount of gasoline is quite characteristic of these distillation operations
3228 1665 for recovering the clean gas oil charging stock.
3229 Defendant meets the carbon problem beyond the cracking coil, that is in the part of the system following upon the pressure reduction valve B as shown on the chart DX 774, in essentially the same way as it is met in the cracking coil itself. Namely, conditions are so regulated as not to form carbon. The
3230 cracking of the stream from the cracking oil is stopped on its entry into the vapor separator by reducing the temperature; the liquid oil in the separator is kept to a minimum quantity, that amount being

what is required to keep the liquid drawoff of the separator sealed against the withdrawal of vapors with the liquid. By keeping the quantity of oil in there small, the time factor of the liquid is minimized. The low pressure maintained in there aids in deriving the vapors out very rapidly also.

There is some carbon produced in this cracking operation over the period of a run which may extend several weeks time. That comes about, of course, because conditions are regulated to try to get as much cracking as one can without reaching the conditions in which carbon is formed. In other words, they try to run to get the maximum amount of cracking which they can without making carbon. Naturally running close to the limit, there is some small amount of carbon produced in one of these runs. And the run
3231 is terminated periodically to clean out the accumulations of carbon and to inspect the apparatus for corrosion and wear.

3231 1666 As to whether the length of the run is limited by the carbon holding capacity of any part of defendant's equipment, I should say that if operating conditions are regulated, or if there is insufficiently accurate regulation so that carbon is formed in the tubes to any considerable extent, then the operation would be shut down by that condition. However, that carbon formation in the tubes brings about an overheating of the tubes rather than a filling up of the tubes and a stoppage of the tubes. You get into serious over-heating conditions with scale of carbon which would not materially reduce the capacity of the tube.

In the cleaning operations the practice in defendant's operation is to clean out the tubes and usually there is perhaps a few wheelbarrow loads of carbon cleaned out of the tubes and the vapor separator—
3232 the carbon which accumulates on the sides and the bottom of the vapor separator, a scale of it which is cleaned off, then there is some accumulation of it in the bottom of the bubble tower also which is cleaned out at the end of the run. A few wheelbarrow loads altogether would usually constitute the cleanings after a normal run.

Sometimes the defendant's process might be shut down because of the small amount of carbon accumu-

lated in the cracking tubes causing them to be overheated; sometimes the run may be terminated just because it has run for a period of time which the operators consider to be safe to run without an inspection of the equipment.

3232 1667 If you compare the actual amount of carbon formed in the period of a run with the amount of cracked gasoline formed in defendant's process, 3233 you would say that the carbon is really insignificant. The gasoline formed in a normal run of one of these stills, the defendant's still in particular, would represent hundreds of tons of material, whereas the carbon would be a few wheelbarrow loads.

Both the vapor separator and the bubble tower in defendant's operation are separating or fractionating devices. The vapor separator serves to bring about the separation of the heavy residual oil from the insufficiently cracked oil vapors and the desired products and the gas, and this is brought about by a cooling action. The bubble tower in the same way by a cooling action separates the insufficiently cracked oil from the desired products and the fixed gas. The vapor separator, of course, has the additional function of being the zone in which the topped crude or reduced crude is vaporized and distilled.

3234 In general, the gas oil which is drawn off as indicated on DX 774 at the bottom of the bubble tower in the line with the arrow going to the right, "gas oil 160 barrels per day", is accumulated during the run so that there is gas oil stock available for putting the equipment into operation on the start of another run. Sometimes there is some inequality in the operation which makes it necessary to take some of that gas oil and feed it back to the bubble tower temporarily during the run, to keep the supply of 3234 1668 charging stock up. But during the run they aim to accumulate gas oil in storage for starting up the next run.

One advantage which defendant gains by returning the material from the bottom of the bubble tower directly to the inlet of the cracking coil over a process where that material would not be immediately returned but conducted to storage and used as a charge on the subsequent occasion is in the saving of heat. As the defendant operates, the oil returns to the

3235 furnace and in a heated condition. It also saves on equipment and in handling costs because if we take the oil out and cool it off that requires cooling equipment and it requires storage to accumulate it, and that requires pumping equipment to put it back in. The heat loss of course could be minimized by the use of heat exchangers which would exchange heat between the oil coming out and the oil going back into the process, but there is a substantial saving in the amount of equipment required and the handling that is necessary in the type of operation where that material is drawn off to storage and charged at a later time.

Immediate return of reflux from the bubble tower does not solve the carbon problem in defendant's operation. The carbon problem is solved in defendant's operation by regulating the conditions so that the carbon is not formed in the process, and those conditions are the use of the clean stock, the limiting of the cracking to that point short of carbon formation, and the regulation of heating conditions so that local over-heating is minimized. Those things would
3236 1669 apply irrespective of whether the oil is returned immediately or returned at some later time.

The defendant's operation is not a pressure distillation operation. It is what we call a coil cracking operation. That is, the oil is cracked as it flows through the coil and the vapors which form in the coil flow along with the liquid to the outlet of the coil so that the vapors are subjected to the same conditions of cracking as the liquid is subjected to. In a pressure distillation operation the oil is cracked in a body in a container, where the vapors may escape substantially as rapidly as they are formed, and consequently when vaporization takes place that part which vaporizes escapes from the cracking reaction, and the cracking is the cracking selectively of the liquid part of the oil. Pressure is used, of course, in the pressure distillation operation to maintain the oil in the liquid condition at the cracking temperature.

3237 The pressure of 26 pounds in defendant's vapor separator is used to force the materials on through the rest of the apparatus and to force the products of the operation out to storage. You notice that the pressure drops between the vapor separator and the bubble tower from 26 pounds down to 24 pounds, so

that two pounds pressure is used there in getting the vapors from one vessel to the other. Then the pressure drops some more in getting the gas and desired products on through the final condenser into the gas separator because the pressure in the gas sep-
3237 1670 arator is 16 pounds, so there is an additional drop of eight pounds in forcing the materials through the bubble tower and the final condenser into the gas separator. And the pressure in these vessels forces the products out to storage.

For example, the residuum from the vapor separator is forced out through the cooling coil and into the receiving tank by this 26 pounds pressure in there. The gas oil product is forced out of the bottom of the bubble tower and through a coil and on out to storage
3238 by the 24 pound pressure in there; and the gas and the cracked distillate, pressure distillate, are forced out of the gas separator into their respective receiving equipment by the 16 pounds pressure in that vessel.

One could very readily change defendant's operation so as to have an operation without substantial vaporization in the cracking coil by regulating the conditions at the outlet of the coil to correspond with the conditions a little bit short of the outlet of the roof tubes where we have the oil in the liquid condition and in which cracking has progressed to a state where six or seven per cent of the gasoline has been formed in the stream. Under these conditions, you would have the oil being heated and cracked in the coil without substantial vaporization.

This would certainly be operable and it might very readily be commercial.

If you desired to obtain more cracking than I have
3239 mentioned, one could set up a vessel on the out-
3239 1671 let of the coil which could be operated at sufficient temperature and pressure so as to continue the cracking and get more cracking in that vessel after the oil is discharged from the coil.

In such an operation it would not be necessary to heat this second drum that I mentioned. I think that operation could be carried on very readily without heating the second drum.

You would not need a pressure of 2,000 pounds on the coil to keep that material in the liquid condition

while being cracked, as that is evidenced by the conditions in defendant's cracking coil where at a pressure of about 600 pounds the oil is in liquid condition and has six or seven per cent of gasoline formed in it.

DX 776 is Plaintiff's Exhibit 37 in the Root case, entitled "Brown Vapor Pressure Chart of Material Entering and Leaving No. 2 Coil of Defendant," and
3241 was introduced in the Root case by Dr. Brown to illustrate the conditions of temperature and pressure necessary to cause the material which was charged to the cracking coil in that operation to be either liquid or vapor, or part liquid and part vapor, and to show the same information with respect to the cracked products leaving the cracking coil.

Now the larger one of these curves shows the temperatures and pressures required to maintain liquid conditions and to maintain vapor conditions, and to maintain part liquid and part vapor conditions on the oil which had been cracked in defendant's cracking coil. In that process, in that operation of the Root process cracking was carried on in the coil to the
3241 1672 extent of making about 17 per cent of gasoline in the oil as it left the cracking coil.

Now looking at the upper line in the large curve, you note that line is marked "Zero per cent vapor." In other words, that line shows the temperature and pressure conditions necessary to keep that material in
3242 the liquid condition. Temperature is shown along the horizontal line. Pressure is shown along the vertical line. So that at any point along this curve we have the temperature and pressure conditions necessary to maintain that material in the liquid state.

I would like to refer to the point which shows a temperature of 860 degrees on that chart, 860 degrees Fahrenheit, which I will mark with the letter A.

Now if we read back across horizontally to the pressure scale, we find that the pressure corresponding with that point is approximately 850 pounds per square inch absolute; that would be about 835 pounds gage pressure. That shows that that material would be entirely liquid at a pressure of 835 pounds gage, at a temperature of 860 degrees, and that material as I say contained about 17 per cent of gasoline.

Now I have not checked the data on this curve, and

I have not attempted to check it, but that is what it shows.

3243 The residuum made in defendant's operation is a fuel oil of approximately 10 gravity. That is, translated into non-technical terms, it has practically
3243 1673 the same specific gravity as water. The residuum is of sufficiently low viscosity and sufficiently clean so that it makes a very satisfactory industrial fuel oil and it is sold for that purpose.

3244 It makes a satisfactory fuel oil because the cracking in the process has been kept short of the conditions for forming substantial amounts of carbon. If cracking had been allowed to progress farther, one would undoubtedly get somewhat higher yields from the oil but the cracking would produce carbon which would make the fuel oil less desirable for industrial purposes.

The length of run of a process is not the criterion of the commercial value. Length of run does not necessarily determine the value of a process at all. One may have a very valuable process which makes quite short runs and then requires shutting down for cleaning out. On the other hand, one may have a process which would run almost indefinitely and yet would not be desirable because the yields from the charging stock or the cost of operation might be such as to make it uneconomical.

In considering the commercial advantage of a cracking system, one would naturally consider the invest-
3245 ment cost in the first place, how much it cost per unit of producing capacity. Another factor would, of course, be the operating cost of the process. Another factor would be the type of material which could be charged to the process, whether it required an expensive type of material or whether a cheap type of material could be charged to it. Another factor
3245 1674 would be the quality of the product produced from the process. And of course an important factor would be the yields of the desired product produced from the process.

3246 Defendant's process makes an excellent grade of cracked gasoline. The characteristics of this gasoline with respect to anti-knock particularly reflects the operating conditions. That is, the high temperatures used in this process are conducive to the production of

gasoline of good anti-knock properties. Their volatility of the gasoline is also good.

3247 The coil cracking process which the defendant uses produces a higher anti-knock gasoline than the gasoline produced by this Jenkins pressure distillation process which operates at lower temperatures.

There are elements in common between the process of the Dubbs patent and the defendant's operation. Both are cracking processes. Both are continuous cracking processes. Both use coil type heaters, and both return reflux. Both condense the final product and draw it off; and both withdraw residue from the operation. Perhaps there are other points of similarity between the two.

I now compare what takes place in the B tubes of 3248 the Dubbs process with what occurs in the defendant's cracking coil.

The B tubes of the Dubbs process are or make up the first part of the cracking zone of the process. In these tubes which the patentee calls the cracking 3248 1675 tubes and the heating tubes and the B tubes, the cracking heat is imparted to the oil and the cracking is initiated. Cracking is limited at any particular pressure condition by the requirement that the heating shall be accomplished without substantial vaporization in these tubes. That is, cracking is not to be allowed to progress to the point where it results in substantial vaporization in these B tubes.

The oil is discharged from these B tubes in the heated condition for the additional cracking which is to be given it in the other part of the cracking zone.

In the defendant's cracking coil the oil is fed through in a continuous stream. It is heated continuously as it flows through the coil. Cracking is initiated and carried on to completion in this coil while it is 3249 being heated. Vaporization takes place in the coil. So that by the time the oil leaves the coil 85% by weight of the stream of the oil has been vaporized and the vapors occupy 95% of the space in the coil.

The Dubbs cracking zone, as I have said, is made up of these two parts; the cracking tubes where the cracking heat is imparted to the oil and cracking is initiated, and the vaporizing tubes where the cracking continues, vaporization takes place as the result of cracking, and which are not to be excessively heated

so that carbon may be formed and precipitated in these tubes.

This divided cracking zone is essential to the principle of the fireless cooker type of operation. The defendant's cracking coil on the other hand is a
3249 1676 continuous coil, it is uniform in cross sections, the oil is continuously heated throughout the length of the coil; the cracking is initiated, progresses and is completed in its passage through the coil while the temperature is constantly rising, and the vaporiza-
3250 tion takes place in there. No separation of the vapor from the liquid takes place in the cracking coil in the sense of segregation into a layer of liquid flowing along the bottom of the coil and a layer of vapor flowing along in the top of the coil, so that the vapor and liquid flow along together and both are subjected to the same degree of treatment.

No carbon formation may be permitted in the cracking coil of the defendant's operation because carbon formation therein would result in the shut-down of the process. The cracking zone, the divided cracking zone principle of the Dubbs patent permits carbon to be formed in large quantities without harm to the operation.

3251 I now compare what occurs in the C tubes of Dubbs with what occurs in defendant's vapor separator.

Again the C tubes in the Dubbs patent are the sec-
3252 ond part of the cracking zone wherein the cracking which was initiated in the B tubes is continued, and where vaporization takes place as a result of the cracking, and where the vapors are permitted to escape as they form, cracking may be carried to the point where carbon is formed and deposited.

3252 1677 In these C tubes every effort is made to maintain the cracking temperature and to maintain a pressure appropriate for the cracking operation, efforts being, however, to keep short of the application of any excessive heat to these tubes.

In defendant's vapor separator, on the other hand, conditions are set up to stop the cracking, prevent further cracking from taking place, pressure is very markedly reduced from 500 pounds down to 26 pounds. The oil is cooled by the introduction of a cooler stream of fresh charging stock, the amount of liquid in the

vapor separator is held to a minimum sufficient to seal the outlet from the loss of vapors, that is to seal the liquid outlet from the loss of vapors.

I think I failed to mention in connection with the C
3253 tubes that a substantial amount of oil is kept in those tubes to provide the time factor for cracking.

Residue is withdrawn from the Dubbs cracking zone. In defendant's cracking furnace the entire cracked products are discharged together as a mixture. There is no separate withdrawal of the residue from that furnace.

3254 Using the data of the illustrative run of the Dubbs patent and assuming that the vapors are formed in the B tubes, a velocity of ¾ of a foot per second would not prevent the segregation of vapors from the liquid.

That is not enough velocity to prevent the seg-
3254 1678 regation of vapors from liquid under those conditions.

I would like to point out, first of all, that a velocity of ¾ of a foot per second is an extremely low velocity. That velocity is such that it would represent traveling a distance of a mile in about two hours. Now one
3255 would have to walk at a pretty slow rate if you used tw hours in walking a mile. I simply cite that to illustrate what a low velocity that is.

Now based on my experience and observations, that velocity is considerably below the velocity necessary to keep vapor and liquid mixed up together. I have often observed visually something which I think is comparable for comparative purposes, and that is, in the operation of distilling crude oil where the light gasoline from the crude oil is running out of a 4-inch pipe into one of these look boxes where you can see the stream, the crude that I have in mind, which I have observed many times, contained enough highly volatile constituents that some of these constituents were not condensed, so that the stream coming out of this 4-inch pipe into the look box was a mixed stream of liquid and vapor, and that stream flowing out of that 4-inch pipe at a velocity in excess of 3 feet per second was perfectly separated in the sense of having the liquid flowing along the bottom of the pipe and the uncondensed vapor flowing along the top of the pipe.

3256 Now the conditions in defendant's vapor separator have been used as a basis for determining
3256 1679 whether vapor and liquid would or would not separate at certain velocities and under certain conditions. That, in my opinion, is distinctly not a comparable basis for making that sort of a determination.

In defendant's vapor separator, first of all, we have the residual products from the cracking operations, that is this 10 gravity fuel oil. The fuel oil, of course, is a higher viscosity material than a gas oil would be, and hence has a greater tendency for foaming than a gas oil would have. However, that factor I think we may consider as insignificant in making our comparison because the really important thing there is that in this vapor separator the mixed stream of vapor and liquid enters near the bottom, and the vapors flow up, the liquid must flow down against the vapors. Therefore we have a condition of countercurrent flow, vapor flowing up and liquid flowing down.

That is not the condition which one encounters in a
3257 stream of oil in a pipe flowing along horizontally, because there the vapor and the liquid both are flowing in the same direction. In other words, they are flowing concurrently and not countercurrently.

In my experience with the Jenkins cracking operation I have a much better basis for determining whether or not the vapor would separate from the liquid at specific velocities.

This sketch DX 777 of this Jenkins operation is one that has been used previously in litigation to show this operation.

3257 1680 I will briefly describe this Jenkins operation. The still was composed of three drums, an upper drum or longitudinal drum which was six feet in diameter and approximately 35 or 40 feet in length.
3258 Then there were two transverse drums located below the upper longitudinal drum. These were also six feet in diameter and were connected into the upper drum by sluiceways. The transverse drums served as headers for a bank of tubes connected in parallel. And this bank of tubes was located inside of a furnace so that they could be heated.

The structure of the still is quite similar to that of a conventional water tube boiler

The oil which was subjected to cracking filled the tubes, the two transverse drums, the sluiceways, and approximately half filled the upper longitudinal drum. This oil was circulated down through the rear sluiceway, the longer sluiceway, into the lower transverse drum and up through the bank of tubes into the upper transverse drum, and up into the longitudinal drum through the sluiceway where it flowed back to the rear sluiceway once more and down into the lower transverse drum.

This circulation was brought about by a regular ship's propeller rotating in this rear sluiceway so that
3259 it circulated the oil through this cycle at a rapid velocity. The velocity through the tubes was approximately 10 feet per second. The velocity of flow of the oil in the longitudinal drum carrying the
3259 1681 oil from the front sluiceway back to the rear sluiceway was in excess of 4 feet per second.

Now the charge to this process was 32½ gravity gas oil from Mid Continent crude. The pressure used in the process was from 110 to 115 pounds. The temperature ranged from about 750 to 765 degrees.

Now the oil cracked throughout this circulating mass. Vapors were formed and the vapors separated themselves from the liquid in this upper longitudinal drum. That is, while this oil was flowing along in a horizontal direction in this drum at a velocity in excess of four feet per second the vapors rose to the surface of that liquid and escaped into the upper part of the drum and passed out through the vapor pipe into the dephlegmator.

Now I say that that does give us a comparable situ-
3260 ation to the situation one would have in the Dubbs patent using the conditions of the illustrative run; whereas, the conditions of defendant's vapor separator are not comparable to that, and since vapors would separate themselves from the liquid when the stream was flowing at a velocity in excess of 4 feet a second, I say, clearly that a velocity of ¾ of a foot per second in the B tubes of the Dubbs patent is not sufficient to prevent those vapors from rising to the top of the tube and flowing along the top of the tube,

whereas the liquid would be flowing along the bottom of the tube.

3260 1682 Disregarding for the moment my opinion that defendant's process is one which will satisfactorily crack oil, whereas the one described in the Egloff patent does not satisfactorily crack oil, I should say there are some elements in common between them.

For example, we have two furnaces, or rather, we
3261 have two heating coils. The topped crude is heated in one of these coils and reflux condensate is heated in the other coil. Both coils discharge into an enlarged vessel. Both withdraw residue. Probably some other points in common also.

I now compare the process of the Egloff patent with the process of the defendant's operation. In the first place, the Egloff patent is directed to an improvement in the pressure distilling type of cracking operation. The defendant's operation is a coil cracking operation. The cracking in the Egloff patent, if any cracking occurs, would be the cracking in the expansion chamber. The cracking in the defendant's operation takes place in the defendant's cracking coil.

The Egloff patent teaches that the oil in coil 6 is to be heated under pressure and that the oil is to be delivered to the expansion chamber substantially in liquid phase. The defendant's operation, on the
3262 other hand, heats and cracks the oil in the cracking coil to the extent that 85% by weight is vaporized by the time it leaves the coil; that is, it leaves the coil substantially in the vapor phase.

The expansion chamber of the Egloff patent is a vessel which is to be operated under pressure to
3262 1683 bring about distillation at a temperature which would promote cracking. The defendant's vapor separator in comparison is a vessel used for separating the cracked products from the cracked—or the cracked residue from the other cracked products, and for separating the clean gas oil stock from the heavy dirty constituents of the topped crude. A small amount of liquid is maintained in defendant's vapor separator. A substantial body of liquid is to be maintained in defendant's vapor separator. A substantial body of liquid is to be maintained in the ex-

pansion chamber of the Egloff patent so as to promote cracking therein.

1684 *Cross-Examination by Mr. Hall.*

3266 In employment by the Skelly Oil Company as assistant superintendent of the refinery from 1927 until 1938 I was located insofar as my duties were concerned at Eldorado, Kansas. In my employment by the Barber Asphalt Company I was located so far as duties were concerned at Barber, New Jersey.

3267 During the years I have referred to, say, for example, during the period of ten years last past, I have had other activities remote from those two places in connection with some of these oil cracking suits. I had some activities beginning about 1930 in connection with the case of the Universal Oil Products Company *vs.* Root Refining Company.

I did some inspection work in connection with suits against the White Eagle Oil & Refining Company about that time and I have had some activity through the ten-year period in connection with the accounting case of the Universal Oil Products *vs.* Skelly Oil Company on the Jenkins stills.

3268 I had some activity in connection with the case of the Standard of Indiana *vs.* The Globe Oil & Refining Company of Illinois. That was the case in which this inspection was carried out at the plant at Lemont, which I participated in, in 1933 that I mentioned on my direct. The case of the Gasoline Products Company *vs.* the Champlin Oil & Refining Company, the case of The Texas Company *vs.* the Anderson-Prichard Oil Company, the case of the Universal Oil Products Company *vs.* the National Refining Company and, I believe the case of Gasoline Products

3268 1685 Company *vs.* the National Refining Company. Some activity in connection with this case, of course. I don't think of any others at the moment.

I testified as an expert in the case of the Gasoline Products Company *vs.* The Champlin Refining Compand and in the case of The Texas Company against the Anderson-Prichard Company and in the accounting proceedings of the Universal *vs.* Skelly on the Jenkins cracking process.

3269 I also testified in the case of Universal *vs.* Root

Refining Company as a fact witness on behalf of Root Refining.

In the suits in which I testified as an expert I described the operations of the stills. In the Root suit I described some phases of the operation of the still; I didn't discuss the Dubbs patent in the Root suit at all.

I testified in regard to the operation of the Winkler-Koch cracking process as carried out by the Root
3270 Petroleum Company and as carried out by the Skelly Oil Company. I didn't describe that operation in the way I have described the accused process in this case. I merely discussed some phases of the operation in that case. I have discussed the operation completely in this case.

I had some activity in connection with the Danciger case, Universal *vs.* Danciger. I took part in the inspection of that plant in connection with that case. I have been in consultation with the attorneys for the defendant in all these cases.

1686 I was at Wilmington during the entire trial
3271 of the Root case and I was in consultation with present counsel for the defendant in some respect, I suppose you might call that advising them. I discussed with them some of the technical phases of the case which they wanted information about.

Except the Skelly case, all of these other cases involved this Winkler-Koch process.

In connection with one or more of these suits I visited the operation of a still at McPherson, Kansas, several times. I was not there continuously during the inter-parties tests that were made. I visited that still to observe the operation and to generally acquaint myself with what was being done there. The
3272 purpose for which I went there was not to qualify myself so I could testify if called upon in regard to that operation. It wasn't idle curiosity that I went there. I went to see the operation to generally acquaint myself with what was going on. It was a test which had to do with some of these cases and I was interested in seeing what the general nature of it was. I don't recall distinctly if I gave any suggestions at all in connection with that operation. I may have, some general suggestions.

3273 There were several of these cases which that opera-

tion was connected with. I believe the National Refining case was one, the Texas *vs.* Anderson-Prichard was one, and the case of Universal *vs.* Globe of Kansas, and I believe this case here.

For my services in these activities that I have just referred to I have always sent my statements to
1687 the Winkler-Koch Patent Company and have been paid by the Winkler-Koch Patent Company. They paid me for all my services in connection with these activities. That was payment apart from my regular payment for services as assistant superintendent. When I was on these cases I was released temporarily from the services of the Skelly Oil Company. That, of course, was with the exception of the
3274 accounting case of Universal *vs.* Skelly. There I was paid by Skelly. I testified at considerable length in that case, not in the main case but in the accounting proceedings, as to the operation of the stills and what not.

To my understanding, the general use of the word "evaporation" is as a symbol for an operation in which the material which is left behind is the desired end product of the process.

3275 It is generally correct that I use the word "distillation" as a symbol for an operation in which the material separates itself from that which is left behind, and that material which separates itself is recovered and is the desired product of the operation. The distillation concerns itself more with the part which is vaporized and the recovery of that vaporized material.

Q. I believe it was Aristotle who was one of the first to use what is ordinarily called a distillatory process for the purpose of recovering drinking water from sea water. Now, if we had a process consisting of a container in which we would put sea water, and a condenser, and a receiver for the condensate, and we operated that process to recover water for drinking and salt for use as a condiment, what would that be?

A. Well, I think we would generally class
1688 that as a distillation process. I did not mean
3276 to say that in a distillation process you totally disregarded the unvaporized material, but the distillation term is applied generally to one of these opera-

tions where you are concerned with recovering the part which is vaporized.

Q. Getting right in the petroleum industry, if we carried out the practice which has been carried out, using Pennsylvania crude to recover cylinder stock, where we drive off by distillation all material boiling in a lower temperature than the cylinder stock, and the cylinder stock is the residue and is the desired product, is that evaporation or distillation?

A. Those operations are generally called distillation operations. You see, you can't make a hard and fast distinction there on these operations and say one is evaporation and the other one is distillation, because just as in that case very frequently you are concerned with recovery of both the part which is left behind and the part which vaporizes off, but that particular example I think we will generally classify as a distillation operation.

3277 In a general way I am familiar with this old process of treating Pennsylvania crude to recover cylinder stock. In this operation we put a batch of oil in a shell still, Pennsylvania crude in a shell still, and we heat that oil and generate vapors.

Q. These vapors liberate themselves from the non-volatilized oil, which is to constitute the cylinder stock, do they not?

A. Well, now, in what sense are you using
1689 "liberate," there, Mr. Hall? Do you mean they liberate themselves in the sense that they rise to the surface and segregate themselves in a layer above the liquid layer in the still?

Q. I use it in the same sense we speak of Mr. Lincoln having liberated the negroes. That is, they pass out of the non-volatilized oil and on to the overhead mechanism of the still or the condensing mechanism of the still.

A. Oh, you are using it then in the sense of passing out of the still into the condensing apparatus?

3278 Q. Not passing out of the still, passing out of the residue which is left in the still. Do the vapors pass out of the residue, which in this case happens to be cylinder stock, which is left in the shell?

A. Yes, they certainly do. They pass out, as a matter of fact, just the instant they are formed.

3279 I merely wanted to make sure that when we were

talking about liberation we were talking about the
3280 same meaning of liberation. The question then is directed to the vapors passing out of the residue; Yes, the vapors pass out of the residue and the residue, which in this case is cylinder stock, in the assumed case is cylinder stock, is left behind, so that it is correct that you have in a distillatory process steps as follows where a liquid is being treated, where petroleum is being treated: The generation of vapors in the petroleum body, the passage of the vapors out of such body, leaving behind a residue or non-volatilized oil, the withdrawal of such residue
after the vapors have separated themselves from
1690 the residue, and the condensing of the vapors which pass on to provide a distillate. You have all those steps.

There is a familiar process where, instead of applying the heat directly to the shell still in this same sort of a distillatory process for obtaining cylinder
3281 stock and an overhead product, where the oil is heated, receives all of its heat in its passage through a pipe heater, which pipe heater discharges into a shell, and there the generated vapors separate themselves from the non-volatilized oil which forms ultimately this cylinder stock. Now, when we say "separate" there we are talking about separate in the sense of disengaging themselves from the liquid body and passing on out. We get a residue and we get an overhead
3282 product.

Q. Then in that kind of a process also we withdraw the residue after the separation, do we not?

A. Well, we actually withdraw it during the separation operation.

This residue we withdraw, we certainly don't desire that it shall contain any of the material which has been converted to a vapor. We don't desire to withdraw any of the low boiling material, with the residue. We agree on this then, that we withdraw the cylinder stock or the residue substantially freed from the vapors. Otherwise we wouldn't have cylinder stock. In order to get cylinder stock we must vaporize the oil and we must pass the vapors out of the oil,
3283 and then we must withdraw the residue. I don't mean to quibble on that but the point is that you are

withdrawing the residue during the operation of
1691 separation there. That is the only point I wanted to make perfectly clear. The residue which is withdrawn is intended to be freed of the vapor portion; or you can just leave that residue in your still until all your vapors are off and then withdraw it. You can discharge into a still from which you are withdrawing nothing and accumulate the residue in there and then draw it off at a later time. It is quite correct that you could heat all your oil, run it into a shell or cylinder, pass your vapors out of your non-volatilized oil to a condenser, and the next day, if you wanted to, draw off your residue, which would be the cylinder stock. In that case you would be withdrawing it after the separation opera-
3284 tion had ceased.

The Court: Is there any dispute about that. I think we are spending a good deal of time on something that is obvious.

Mr. Hall: Well, I thought so, Your Honor, but possibly it wasn't.

When you say that the "melody" of my deposition is that the term "without vaporization" in the Dubbs claims inhibits vapor generation in the B tubes, and in consequence other than for incipient cracking therein that this confines the Dubbs process to what I likened to a fireless cooker procedure in which all heating is done in the B tubes but substantially all
3285 cracking is done in the C tubes, and that this process is a fine useful process, that isn't a correct statement of it. The fireless cooker principle is taught in the specification of the patent, as I pointed out very definitely. This requirement that the heating in the B tubes be done without substantial vaporization, that appears only in the claims.

1692 I didn't mean to give the impression that a primary contention that I made is that due to the term "without substantial vaporization" as I found it in the patent, that the Dubbs process is confined to one where there is no substantial vaporization in the B tubes, and practically all of the cracking is done in the C tubes, and that that is a very good and useful
3286 process. I did mean to say this, that at the low pressure taught in the illustrative run of the patent the amount of cracking which could be accomplished

without substantial vaporization or vapor generation, if you prefer to use that, would be quite small. Now, if you go to higher pressures you can increase the amount of cracking there without getting into substantial vaporization.

Q. Well, then, is the balance of the question correct or does it express your views, that that operation where you have no substantial generation of vapors in the B tubes and no substantial amount of cracking in the B tubes, but substantially all your cracking takes place in the C tubes, is a useful process? Now, did you say that or didn't you say it?

3287 The Witness: It seems to me that question is a little confused there. It is confusing vaporization and cracking in the B tubes, if I understand it correctly.

Mr. Hall: Well, as I understood you, you said there was no substantial amount of vapor generation in the B tubes, isn't that your representation as to the Dubbs patent?

A. That is what the claims call for, yes, sir.

Q. Well, that is your representation as to the Dubbs patent, is it not? Isn't that what you told the Court.

1693 A. Well, when you take in the claims, yes, that is true.

I also told the Court that there was no substantial amount of cracking in the B tubes at the low pressure taught in the illustrative run, but I think I made it quite clear that higher pressures would permit more cracking without substantial vaporization; by low

3288 pressure in the illustrative run, I mean approximately 100 pounds. With a 36 Baumé gravity oil, Kansas or Oklahoma oil, gas oil, the boiling range would depend on the type of operation in which it was produced, to a certain extent. It might be a narrow boiling range oil with 36 gravity or it might be a wide boiling range oil, but I should say probably the way that sort of a gas oil is generally produced it would be something having an initial boiling point around 500 degrees and an end point somewhere around 700 to 750, I would have to look up the end and initial boiling point of that oil at 100 pounds pressure on charts in order to give that to you accurately. Very approximately, let us say, it would be 200 to 250 de-

3289 grees higher at 100 pounds. A fair figure would be in the neighborhood of 700 initial and 900 end. It might be a little more than that or it might be a little less than that, I think probably a bit more than 700 and 900. Of course when we talk about an end point of 900 degrees we are talking about a theoretical thing, because you can't actually distill the oil at 900 degrees without cracking it. The boiling point at 50 per cent off would be somewhere around 800 degrees, I should think. I hope you won't hold me too closely to those figures, because if there is anything critical about them I would like to refer to the charts.

3290 1694 Q. Taking the illustrative run, then, which is given in the Dubbs patent, with 100 pounds pressure and 860 degrees Fahrenheit, and considering the amount of reflux, about what amount of vaporization would you get entirely apart from cracking—what amount of vapor generation would you get entirely apart from cracking?

A. Well, you have introduced an uncertain element in there which would require evaluation in the introduction of the reflux. That reflux could be of a widely varying character and could be a widely varying amount.

Supposing we were only running this 36 Baumé gas oil we have been referring to under 100 pounds pressure and at a temperature of 860, not considering the cracking phenomenon at all, eliminating the cracking, the conversion to vapor would be very substantial.

3291 Q. Now, if we put the cracking in, the vapors due to cracking, we would get still more vapor generation, would we not?

A. Any cracking which took place would increase the vaporization.

And if we considered the reflux which would be present in a Dubbs operation; meaning by Dubbs operation where you pass the oil through cracking tubes B and heat that oil to 850 under 100 pounds, and then pass it over into a vaporizing chamber and take out your vapors and subject them to partial condensation, and return a part of that condensate back to your heating tubes with your fresh oil to

3292 1695 form a combined feed; and always talking about the Dubbs operation of the patent, I think that it is a fair statement that we would get still more

vapor generation. That sort of a run is referred to in this illustrative example, in the illustrative example he gives that temperature, he gives that pressure and he gives that gravity of charging stock. That is quite correct.

Q. Consequently, considering such a run as that and considering your interpretation of the word "vaporization", the two don't fit at all, do they?

A. No, they don't fit.

3293 I won't agree to the statement that taking my interpretation of "vaporization", the claim is not only unsupported by this illustrative run but it is entirely contrary to the conditions which would obtain in that run because you picked out in that just part of the conditions given in the illustrative run. You have picked 36 gravity gas oil. You have picked the highest temperature given. And I say taking those particular conditions your claims don't fit with them, but those aren't the only conditions given in the il'ustrative run.

Q. So far as those conditions are concerned, which are conditions given as illustrating a representative run, the word "vaporization", giving it your interpretation, would make all of the claims of the patent wholly inconsistent with such typical run?

A. If you are going to confine it to those particular conditions—the claims don't fit that set of conditions.

3294 Now, dropping down from 860 temperature to say 830, the same probably would be true to a lesser
3294 1696 degree. Supposing we drop down to 800 degrees temperature, the same thing might be true. I thought I made it perfectly clear on my direct that the lower part of the temperature range of the illustrative run was the only part which would permit you to operate without substantial vaporization in the B tubes. That is, that was the only part which by any possibility would support my interpretation of the word "vaporization" and make the claim to the patent read upon the typical run of the patent at approximately 100 pounds pressure.

Q. So that you represented to the Court that taking the patent as a whole vapor generation is inhibited and does not occur in the B tube of the Dubbs patent, isn't that correct?

A. The patent instructs that the heating in the B tubes is to be accomplished without substantial vaporization, that is, without substantial vapor generation.

3295 Q. All right, then that is correct, the proposition I put to you, isn't it?

A. I believe that it is, if you mean the same thing which I stated.

Q. You also said that no substantial cracking occurred in the B tubes of the Dubbs patent, didn't you?

A. At the 100 pounds you couldn't get very much cracking in the B tubes without substantial vaporization. You have to go to higher pressures in order to accomplish substantial cracking in the B tubes without substantial vaporization.

3296 It is not my view, considering the Dubbs patent as a whole, that you don't get vapor generation 1697 in substantial amount in the B tubes and you don't get cracking in substantial amount in the B tubes. It is my view that the Dubbs patent calls for liquid phase cracking practically exclusively in the B tubes, if any cracking occurs there. It is my view that that sort of a process could be very useful.

Q. Did you distinguish or do you distinguish the 3297 process of the Dubbs patent from the accused process you get all of the cracking in the pipe heater or the heating coils?

A. That is one of the distinctions, and I am speaking there of the cracking of that stream. Now, we have got to exclude the incidental cracking of the topped crude which takes place in the vapor separator and which is no part of the feed and reflux cycle in the defendant's operation.

I am not misled by using this term "pipe heater". That is a familiar term in the art. You can have that type, that form of heater, in contradistinction to a shell heater, pipe heater. I understood you to mean a pipe heater. That is the furnace coil of the defendant's operation.

Q. Well, you now say, do you, that all of the cracking does not occur in the pipe heater, is that correct?

3298 A. I said there was this incidental cracking of the topped crude which takes place in the vapor separator. Now, that is a part of the cracking—if you want to be technical about it, it is a part of the cracking of

the whole process, but it is not a part of the cracking of the feed and reflux cycle through the pipe heater into the vapor separator, into the bubble
1698 tower and back into the pipe heater.

I mean by that that the material which is discharged from the high temperature coil is not cracked in the part which is marked "separator" or part called separator in defendant's setup. I say that that makes the accused operation radically different from the process of the Dubbs patent. That is one of the things. I wouldn't call the cracking occurring during the operation of the accused process in the part I have called the separator or the tank considerable.
3299 I would call it merely incidental cracking. Referring to the chart, Plaintiff's Exhibit 508, which gives the stipulated operation it shows a total of 1860 barrels per day of gasoline produced in the process. I think you have to consider the total amount of cracking if you are going to determine the cracking in the tank or separator is important or not. I did not mean to make an argument. I was simply trying to make it clear. The chart shows 6000 pounds per day of gas, 105 barrels per day of gasoline, 20 barrels per day P. D. bottoms, and 120 barrels per day of gas oil made in the tank of separator. The total number of barrels per day in the separator resulting from cracking, leaving out the gas, is 245 barrels.
3300 In the Dubbs operation, speaking of the Dubbs patent, the reflux would probably have a lower boiling point than the fresh feed. Under some conditions it might not.

I will agree that vapor generation excluding cracking is a function of temperature and pressure. As I said, if there is any cracking that increases the vapor generation. It tends to increase the vapor gen-
1699 eration. If it cracks then you get the lower boiling point products. As the result then, you get increased generation at whatever temperature and
3301 pressure you may be operating under. If there is generation without cracking, then cracking would produce additional generation of vapors, but cracking might not cause generation of vapors if there was not generation to start with.

In the Dubbs process the oil reaches its highest temperature during its passage through the pipe

heater or cracking coil B. It reaches the maximum temperature there.

3302 It does not follow that since the oil reaches its highest temperature in the B tubes and the reflux is largely due to material which has been vaporized at that temperature, vaporized in the C tubes and recondensed in the partial condenser, that when it gets back to the B tubes it will be reconverted to vapor. That reflux material is vaporized in the C

3303 tubes, and in the C tubes you have conditions which are distinctly different from those in the B tubes; that is, you have cracking progressing in the C tubes with the formation of all of these light materials. Now the partial pressure effect of these cracked light materials in the C tubes causes these heavier constituents which make up the reflux to vaporize in the C tubes, and when those conditions are reestablished, of course the reflux will again vaporize; but in the B tubes you don't have those conditions, because you do not have all these light materials in the B tubes which are formed by cracking, they only appear again when the oil gets back again into the C tubes.

1700 Getting back to our example where we had the 860 and I said there would be a very substantial amount of vapor generation in the B tubes, that vapor would be discharged into the C tubes with the non-volatilized oil, and then it would separate from the non-volatilized oil and go up to the over-

3304 head mechanism, your partial condenser first, it would separate immediately and pass right on out. Then the part which constitutes the reflux end would come back to your B tubes and it would be converted to vapor in the B tubes when it got back to the same conditions where it was converted to vapor before. That is, this vapor was formed in the B tubes before. Now when that material comes back into the B tubes it is formed there again when it arrives at the same condition.

It would also be accompanied by some material, relatively low boiling material which would be the product of the cracking which occurred in the B tubes and that would make a part of its composition; but that would not make more vapors. I am assuming that we are talking about an operation in which

the operation has been continued long enough to reach equilibrium conditions. Now under the equi-
3305 librium conditions you would have a certain amount of cracking in the B tubes and under this high temperature operation you would have a certain amount of vaporization taking place because of the vapor pressure of the liquid itself and because of the partial pressure effect of the cracked products. You would have that certain amount of vaporization in there, and then when you come back again into the B tubes you come back to this same condition once more. You have a mixture of reflux and fresh
1701 feed established there, and certain compositions, and you have established your temperature gradient through these tubes, and your rate of through-put, and each time when the mixture reaches the necessary temperature under the pressure, why, it begins to vaporize.

When I used the word "vaporization" in the preceding answer I had imposed my interpretation upon it, that is, vapor generation. I think I said a few
3306 moments ago that the reflux would probably be converted at a lower temperature than the fresh feed, and that under certain conditions the contrary might be the case. So, if we have this 36 Baume gas oil and we are heating it to 850, we will say, and passing it over into the chamber C, then providing this reflux, we would have had vapor generation both from that fresh feed and from the reflux in the first place, as I understand it. I thought we were talking about an operation which had been carried on long enough so that we were in equilibrium, we had a mixture of fresh feed and reflux entering the B tubes but maybe I misunderstood you.

We first considered the boiling point of gas oil
3307 and the amount that would be converted to vapor at this temperature entirely apart from cracking, and I said that would be a very substantial amount and I said the reflux probably would boil at a lower temperature than fresh feed. And in the normal operation of the still we had going through this pipe heater and being heated to this 850 temperature, both that fresh feed and the reflux, that is right, we have that mixture.

Now as to the boiling range of the gas oil
1702 which I gave you when you presented the gas oil for the 36 Baume gravity, if you presented the same type of gas oil but having a 32 Baume gravity, in general the heavier the gravity of a cut from a particular crude the higher the boiling range
3308 of it. At a hundred pounds, I gave you a range of about 800 with 50 per cent off. Now with 32 Baume gravity, it is a little hard to say what difference that would make. It might be 50 degrees higher, and it might be more. If you need the 32 gravity instead of the 36 at the same 850 temperature and 100 pounds you would get a substantial vapor generation somewhat less than you would with a lighter gas oil. I cannot say how much less. I cannot say at 50 per cent off, what the difference would be. Those gravity and temperature relationships are not definite enough to give you a definite answer on that,
3309 Mr. Hall. Having in mind the conversion of the liquid into vapor, pressure performs exactly the same function whether you have mixed phase cracking or liquid phase cracking to the extent you have liquid, the pressure retards the conversion of the liquid to vapor. I think that that function of pressure is exhibited in the operation of the accused process is true. The vaporization, vapor generation would start earlier in the coil with a lower pressure than it does at the pressure used.

The yield of gasoline on the charge obtained in the operation of the Jenkins still of the Skelly Com-
3310 pany was generally about 28 to 30 per cent. That was based on the laboratory tests which we make to determine cracking, that is the per cent that is recovered at a vapor temperature of 410 degrees
1703 in the regular laboratory distillation. Referring to the last paragraph on page 2 of the Dubbs patent, that says: "the gravity of the dis-
3311 tillate discharge from the water cooled condenser is about 52 to 56 Baume.",—that is roughly approximating the gravity of the Jenkins pressure distillate,—"and in quantity is approximately somewhat more than half of the gas oil subjected to treatment." Now that pressure distillate would probably have something on the order of two-thirds gasoline content. So if that yield of distillate of that character

was obtained it would be of the order of the amount of gasoline obtained on the Jenkins operation, perhaps a little more.

I apparently gave the impression I was criticizing the scrivener of the Dubbs specification or patent for calling the valve H' a regulating valve, which I did not intend to do at all. That proposition there is perfectly clear to me, what he means, but it does
3312 show a rather loose use of the word. Now answering whether that valve is necessary to maintain in the system the desired pressure, if you just had an open pipe on there, of course everything would run out, you couldn't build up any pressure, but nevertheless that valve does not regulate the pressure, it merely regulates the liquid level, and that is what he says it does down here, beginning at line 105: "The level of the liquid in the tubes C is ascertained by try cocks H^2, H^3, H^4 and the level controlled by valve H'."

Q. Now is it not possible to raise or lower the pressure in the system by operating that valve H'?

A. If you threw the valve wide open I think you would get a drop of pressure, undoubtedly, but
1704 that is not a regulation of pressure.

If you build up residue, you could close the valve so as to not let out as much residue at one time as another, and that might cause a little rise in pressure, but it would not be a regulation of pressure at all.

3313 The Court: Let me ask you, isn't that a rather unimportant point? Of course, if you open this valve it would get out and there would be no pressure. If you kept it closed, there is pressure. I don't see the point is so important to the Court.

Mr. Hall: I don't think it is important, your Honor, except they seem to be casting all aspersions possible on this patent.

The Court: You don't mind the aspersions, do you, as long as they do not affect the validity of the patent.

Mr. Hall: No, I don't, if you will give me that
3314 assurance, why, I don't mind the aspersions.

The Witness: If I may add one point on that, going over to the second page of the patent, beginning at line 55, where he has described the illustra-

tive run, the patent says: "A pressure of approximately 100 pounds to the square inch is maintained on the oil during treatment which is caused by the pressure of the generated vapors". Certainly the regulation of the liquid level valve does not affect the generated vapors.

1705 The words "generated vapors" used in the Dubbs patent are applied to vapors which have
3315 been separated and passed off from the liquid oil, in the specification of the patent. When you ask if by that I merely mean that the generated vapors are used to indicate a phase of the oil which is passed off from the liquid oil, I do not believe I understand what you mean, but perhaps I can clear it up to say that where he uses "generated vapors" he is talking about vapors which are upon the aerial system, he is talking about the condensing of those generated vapors in the aerial system. By that I do not mean that this single point in the specification on page 1,
3316 line 15 which reads: "the oil is continuously fed through the cracking zone and thence through the vapor zone, and a portion of the generated vapors condensed are returned to the inlet side of the cracking zone for further treatment;"—that that statement indicates to me that when "generated vapors" is employed it necessarily means vapors which have been segregated. I did not mean to imply that. It means this to me, that when he uses the words "generated vapors" he applied that to vapors irrespective of whether they are mixed up with oil or whether they are completely separated from the liquid oil, he makes no distinction about generated vapors as being either mixed up with oil or vapors by them-
3317 selves, at that particular point and at another point. At this particular point that you are referring to, all he is saying there is that the vapors after they have separated from the liquid oil in the C tubes, pass up to the partial condenser and a part of them are reconverted to a liquid and returned to the
1706 reflux, and he calls them "generated vapors". This certainly has something to do, some relationship to the original claim 1 of the patent application which stated that the oil and the generated vapors was discharged from the B tubes into the C tubes. It shows the way he used the words "gen-

erated vapors" and he certainly does not use them to mean vapors and liquids mixed up intimately. I do not represent that this part of the Dubbs specification, commencing line 15 and continuing through line 19, wherein the term "generated vapors" is used,
3318 is the part of the specification on which I rely for my representation that claim 1, in referring to oil and generated vapors being discharged from the B tubes into the C tubes, implies that the vapors are not intimately mixed with the liquid oil.

In the heating of a liquid such as petroleum, vapors may be generated either in the body of petroleum or at the surface of the body.

Q. Assume, if your please, that the Court construes the phrase "without substantial vaporization" occurring in claim 1 of the Dubbs patent in referring to
3319 the conditions obtaining in the cracking tubes B to exclude only separated vapors or the separation of vapors from the non-volatilized oil, and does not exclude the generation of vapors, would you then find that the accused process would exhibit a process of converting relatively heavy into lighter hydrocarbons, consisting in passing a stream of oil through a zone where the oil is heated to a cracking temperature, but without substantial vaporization?

A. I think first of all we will have to under-
3320 1707 stand in what sense "separation" is being used there.

Mr. Hall: Q. Well, I am speaking of the separation where the vapors are not intimately intermixed with the liquid oil but pass off from the oil, or as I call it, liberate themselves from the oil and pass off, so that they travel—maybe this will aid you, so that the vapors will travel substantially independent of the liquid oil.

A. You mean so that the liquid would flow along the bottom of the tube, and the vapor would flow along the top of the tube each independent of the other?

3321 Q. That is right.

A. I would say that the accused process does exhibit that if, by "cracking temperature" we mean to include a whole range of cracking temperatures. In the accused operation in the pipe heater the oil is heated to a cracking temperature, heated through a

whole range of cracking temperatures. Yes, it is heated to a cracking temperature.

Q. Now, assuming that the Court interprets the word "vaporization" to mean the separation of generated vapors from the non-volatilized oil, so that a residue may be obtained and a distillate may be ultimately obtained, and that this word is not limited to the generation of vapors, would you then find in the
3322 accused operation the passing of the oil after it has gone through the pipe heater, thence to an enlarged vapor chamber where vaporization takes place?

A. Now, in the first instance, we were considering separation as meaning a stratification of vapors
1708 flowing along above a stream of liquid and the two flowing independently of each other. Is that the same meaning in which we are using separation here?

3323 Mr. Hall: Q. I didn't say anything about stratification. I said, vapors passing from the liquid oil, passing out of the liquid oil. Now of course in a tube where you did not have turbulence you would get stratification, but I say if the Court construes this word "vaporization" to mean the passing of your generated vapors from your residue, from your non-volatilized oil and does not accept your meaning that vaporization necessarily is limited to vapor generation.

Now I want you to assume, if you can, that the Court puts that construction upon the word and with that assumption, answer the question.

A. In this question we are now using it in a different sense than we were in the previous question.

Q. No, no different sense than in the previous question.

A. Then I am afraid I do not understand, Mr. Hall.

Q. Then will you answer this question with the
3324 assumptions that I have put on it and the explanation that I have given you.

A. Yes, I think that would be so.

It is absolutely correct that in the accused operation the vapors are removed from the chamber and pass on to your partial condenser so that such vapors removed from the chamber are subjected to an initial condenser where a portion of the vapors are con-

densed and in the accused operation the uncondensed portion of the vapors is subjected to a final condensation.

3327 1709 And it is correct that in the accused process
3328 you also return the condensate from the initial or partial condensation to the inlet side of the cracking tubes and continuously draw off the residue from the vapor chamber and prevent it from returning to the cracking zone, and you maintain a pressure on the oil during treatment, except that in defendant's operation we have not "a" pressure maintained but a "series" of pressures. When you maintain a series of pressures, I don't think that you maintain a pressure. There are pressures above atmospheric pressure at all points.

3330 The phrase "Removing the residue, after said vaporization", in the claim describes or is applied to
3331 the step of removing the residue from the C tubes and from the cycle of operation which goes on in the apparatus. That phrase doesn't mean an operation wherein this residue is removed while it still contains the vapor, the low boiling material in vapor form.

Q. It means that the low boiling material has been converted to a vapor and that vapor has passed from the non-volatilized material which constitutes the residue, and then that residue is withdrawn from the system?

A. Both of those things have occurred. That is, the vapors have formed and they have passed out of the liquid body. But my point on that was that irre-
3332 spective of that, that doesn't make the vaporization step include the passing off. You see, there are a number of things that happen in those tubes.

Q. In this operation which occurs both in defendant's process and in Dubbs there has been this
1710 step of vapor generation and then the passing off from the non-volatilized oil of the vapors on the way to the partial condenser, and that leaves the residue behind, which is drawn off from the vaporizing chamber or, as I think you call it, separating chamber, so we won't get into a quarrel on vaporizing chamber.

A. I think we probably mean the same thing there.
3333 The only issue I would take with that is that the sep-

arating and the drawing off are taking place concurrently there.

Q. Well, you will agree that we don't get a residue until the generated vapors are separated? I mean from any practical standpoint, now, we don't get a residue, within the purview of the Dubbs patent, which is to be drawn off and which is drawn off, until these low boiling components of the oil have been converted to a vapor and have passed out of the non-volatilized oil?

A. I don't agree with that at all.

Q. Now, is it your contention then that in this operation the low boiling components in the oil are converted to a vapor and while they are still in the oil they are drawn off from the cycle, and that material which is so drawn off is the residue.

3334 A. Now are you speaking of the drawing off of the vapor in that question?

Q. Yes.

A. Or the drawing off of the residue?

Q. No, I am saying is it your contention that the drawoff of the non-volatilized oil with the

3334 1711 vapors and that material is the residue which is drawn off?

A. The residue which is drawn off is the unvaporized portion of the oil, but the residue becomes a residue when the vapor is formed irrespective of whether the vapor is mixed with it or not. Its characteristics are not altered by the separation of the vapor from it.

Q. But for all practical purposes, all useful purposes if we vaporize in an oil the low boiling components, and as you now say you would have then a residue and low boiling components in the residue, in vapor form—that is your contention, is it?

A. Mixed up with it.

Q. Yes—and we drew that off and passed it out of the system, that would be foolish, wouldn't it?

3335 1712 A. It has been done.

It isn't done in either the process of the Dubbs patent or the defendant's operation. In both the defendant's operation and the Dubbs operation you convert the low boiling components of the oil, or some of them, to vapor. Those low boiling components in vapor form then pass from the non-volatilized oil so

you have something that passes on and something which is left behind. The something which is left be-
3336 hind is residue. It was residue before the other material passed on. In other words, I would contend absolutely if I heated material so as to vaporize a part of it but didn't take the vapors out at all I would have a residue and I think I would have a residue which is referred to in this Dubbs patent.

The Court: What is the ordinary meaning of residue?

A. Residue, your Honor, is the material which remains after vapors are formed.

The Court: Isn't it something that is left after something else is done, something that is left behind?

A. Well, I think I haven't made that quite clear. Let us say, for example, that we have in some kind of a closed container a mixture of oil vapor and some residue in there. Now, if that container is quiet so that the two phases are separated from each other the vapor is above, the residue is below, we have the
3337 residue, of course, and we have the vapor portion; but if, on the other hand, that container is agitated so that those two materials are all mixed up to-
3337 1713 gether the residue is there just the same, it has exactly the same properties as it had when it was in a quiescent layer. There isn't any difference whatever. In other words, the mere separating of the vapor and passing off of the vapor from the liquid residue doesn't affect the character of the residue at all. It is residue regardless of whether it is mixed up with vapor or not.

Do I make that clear, your Honor?

The Court: Yes.

That is, according to my contention I form the residue as I form the vapors and it has nothing to do with the passing of the formed vapors out of the non-volatilized oil. It is with that understanding that I have explained the Dubbs patent to the Court.

3338 Q. During your direct examination the Court suggested that in interpreting certain words in the Dubbs patent you should limit yourself to the meaning accepted by scientific men, as I understood the admonition. Now I find that on page 3086 of your testimony you say, "Now, of course, 'vaporization' often is applied, the word 'vaporization' often is applied, to an-

operation where you do have both the vaporization itself and a separating or liberating step in the sense of segregation or passing off."

Q. Do you mean by this that scientific men so use the word "vaporization" as a symbol for the phenomenon which includes both vapor generation and the passing of the generated vapors out and away from the non-volatilized material?

1714 A. No, I didn't mean that because I don't think that is true. I say that "vaporization" is applied or the word "vaporization" is applied to 3339 operations in which you do have both of those steps, frequently, but that doesn't mean that the vaporization includes the separating step or the segregating or passing off step as a necessary element of vaporization.

In the petroleum refining industry I don't think offhand of any useful application of a distilling operation where you have vapor generation unaccompanied by the passing off of the vapors from the non-volatilized oil.

3341 Q. Is it your contention that the man skilled in the art, reading the patent in suit and noting that the tubes B are referred to as cracking tubes, and following the teachings of the Dubbs patent, would not provide either for sufficient heating of the oil or sufficient length of tubes to effect substantial cracking in the tubes, and would not know how to do this?

A. I think a man skilled in the art, reading this 3342 patent, would understand that use of the name "cracking tubes" to mean just what I have explained it to mean, namely, the tubes in which the cracking heat is applied to the oil and the cracking is initiated, because he would read the patent as a whole.

Q. Well, would you say the man skilled in the art, as of the date of this patent, would have been able, calling merely upon his skill, to have obtained substantial cracking in the tubes B either by lengthening the tubes or increasing the oil temperature?

A. Certainly he could design his coil so as to 1715 accomplish substantial cracking in that coil if he desired to. Absolutely.

I didn't say that in the upper part of the actual temperature range given in the specific example in

the Dubbs patent you would get substantial cracking in the tubes B. If you take the example as it is and operate in the upper temperature range you would
3343 not necessarily get substantial cracking. You could certainly make the tubes long enough so that you could get substantial cracking at that temperature. I don't think there is any doubt that the man skilled in the art at the date of the patent would have known how to do that had he desired to get substantial cracking.

Q. Referring to Defendant's Exhibit 774, will you indicate thereon by an X, marked in some color, the parts of the apparatus where the oil temperature is, we will say, at 750 Fahrenheit, or above?

A. I would have to estimate on that, of course, because we have the temperature actually measured at the inlet of the roof tubes as 725 degrees and at the outlet of those roof tubes at 910 degrees. I am marking with an X the approximate point where I think the oil would reach about 750 degrees.

3344 Q. Now, will you continue and mark the various parts of the apparatus where you have a temperature of 750 or above, oil temperature?

A. Well, from that point on through the coil the oil temperature is above 750, and in the vapor separator itself the oil temperature is above 750, and probably in the vapor line out of the vapor sep-
1716 arator up to the heat exchangers, which are indicated by the break in the vapor line, the temperature would be above 750 degrees.

Q. Well, would you put an X1 to indicate the end of that train of mechanism where the oil is 750 or above?

(The witness so indicates.)

Referring to this same Exhibit 774 at the point marked 725 degrees F you have a cracking temperature but not enough time at that point to produce any cracking. It is true that in this chart I have presented, on both sides of the red line indicated thereon
3345 you have cracking temperatures, both the left-hand side and the right-hand side. You have cracking on both sides if you include the incidental cracking of the topped crude which takes place in the vapor separator. On the left-hand side which I have allocated

to cracking alone you have no cracking as to a part of the travel of the oil. In Defendant's Exhibit 774 the red line does not in fact separate those parts wherein cracking occurs from those parts wherein cracking does not occur, if we include this incidental cracking of topped crude.

I don't know exactly the octane number of the gasoline produced in defendant's operation. I should say within the range of about 65 to 70. As to the
3346 octane number of the gasoline produced by the Jenkins operation which I have described, I have to do some estimating because this octane scale was developed in rather recent years and the operation of the Jenkins stills at the Skelly plant was discontinued in 1931, but I would estimate that at somewhere around 55 octane.

1717 I referred to a high temperature vapor phase operation which was operated at the Skelly plant. The still was built in 1927 and we put it into operation just about the end of the year, either the end of 1927 or early 1928. We discontinued that operation in either 1930 or 1931. I am not clear now in
3347 which year it was. I do not see on Plaintiff's Exhibit 508 the pressure at the outlet of the low temperature furnace.

The temperature at the outlet of the low temperature furnace was measured. That is shown on this chart as 720 degrees. The pressure was not measured at that point so that will have to be estimated. It would be somewhat above the pressure in the vapor separator itself because while this is an open transfer line into the vapor separator, from the point where the stream from the low pressure furnace joins the transfer line, still the hydrocarbons are flowing through that short section of pipe at a high velocity and there would be some pressure drop in there. It would be somewhat above 26 pounds.

3348 The operation which I referred to first at page 3166 of the transcript, that is the operation on gas oil, is a once through operation. Then next I spoke of an operation in which that same gas oil is mixed with reflux. Now, that could be a recycling operation or it might be an operation in which the gas oil was mixed with reflux and cracked at some later time.

As to the character of gas oil I had in contemplation for that second operation I had in mind the same gas oil which was used in the first, that is the once through. A great many fresh gas oils or virgin gas oils, as they are called—that is gas oils which have not
1718 been cracked—would be crackable to the extent of 30 per cent without forming and depositing carbon.

3349 I didn't have any specific one in mind but I will give you a specific example. Take the kind of gas oil which we used to produce at the Skelly plant at Eldorado from the simple distillation of crude oil, that would be about a 33 or 36 gravity gas oil, from mid-continent crude.

In the second case, one would have a wide range of reflux ratio and come within that. My point on that is that if you mix reflux with that gas oil then that mixture has to be cracked to a lower yield in order to avoid carbon formation than if you cracked the fresh gas oil alone. Now, you could use more or less reflux. Of course the more reflux you use the lower
3350 conversion you would have to take on it.

When I speak of that second paragraph as to that second operation "with that same conversion", I am referring to the 30 per cent gasoline based on the charge conversion. What I was speaking of there was simply by way of illustration. Say we take a gas oil which would stand conversion up to 30 per cent and not develop cracking, or not develop carbon and coke deposition, in a once through operation, but gas oil of such characteristics that if you went materially above that you would get carbon or coke formation and deposition. Such a gas oil could be obtained, of course. Now, if you take that same gas oil and mix
3351 it with reflux and try to convert it to 30 per cent, then you would run into this coke formation in it. In other words, the addition of the reflux to that gas oil reduces its—what shall we call it—conversion
1719 tolerance.

I didn't have in mind that I would have a recycle operation in which I would extract from my cycle some of the reflux and then at some subsequent time I would take that reflux and mix it with this fresh

gas oil and use that as a fresh feed in a recycle operation. I meant that the once through operation mentioned in the first paragraph could be operated on the fresh gas oil alone.

Now, this same once through operation could be operated on that same gas oil mixed with reflux. The reflux would be withdrawn from the operation on the fresh gas oil alone. It would be the insufficiently
3352 cracked distillate oil which would be produced in the once through operation. I mean I would go into a dephlegmating chamber, we will say, or a bubble tower, and part of the vapors would pass overhead and the balance of them would be condensed, and it is that condensate I am calling reflux. One way of doing it would be to take that reflux, and then to mix that reflux with this virgin gas oil and run it in a once through operation. I say if you crack that then to the same degree so as to get 30 per cent of gasoline from it, then in that operation you would be developing coke formation. In other words, the mixture of the fresh with the recycled oil would have a less con-
3353 version tolerance than the fresh gas oil alone. You would get your cracking carried to a point where coke would form. Whether it would be baneful or just inconsequential, innocuous, would depend upon how much reflux you had in there. Of course, the more reflux, why, the less conversion tolerance you
1720 would have. In my other example I put it in a system where I have recycling. That is true. I then get the same sort of result. That is, you couldn't with that recycling operation go to a conversion per pass of 30 per cent of gasoline without developing coke or carbon formation. Taking the total operation in a recycle, you could get very definitely greater yield
3354 of gasoline, but I was talking about the degree of cracking in going through the cracking operation once. In other words, this conversion I am referring to in the second example on page 3166 is conversion with the single pass. The more reflux you added to the virgin oil the shorter your run would be or the lower the gasoline conversion per pass would be, that is correct. In a once through, just the once through operation, not recycle, the more reflux you

added the less your yield without running into coking conditions on a single pass through the equipment.

3355 Referring to the Egloff patent No. 1,537,593, I can't say that I find that a teaching of an object in this patent, forgetting for the moment whether this object is realized or could be realized, is to provide for the formation in situ from a high boiling oil passed through a low temperature furnace and discharging with oil from a high temperature furnace into a large chamber and then into a dephlegmator, a charging stock for the high temperature furnace. I find that in the Egloff patent and in the accused operation, alike, there is a dephlegmator from which products from both a low temperature and high temperature heating coil discharge; and in both of those alike in the dephlegmator what might be called
1721 intermediate boiling oil is discharged from the bottom of the dephlegmator and the lowest boiling fraction passes overhead to a final condenser to become the final product.

3356 This intermediate oil which passes from the bottom of the dephlegmator is made up in part from the vapors of the oil which have passed through the high temperature furnace and the vapors of the oil which have passed through the low temperature furnace. That is also true in defendant's. In both of these devices relatively high boiling oil is passed through a low temperature furnace. That is the teaching of the Egloff patent and that is the way the defendant operates. In both of these operations the transfer line from the low temperature furnace intersects with the transfer line from the high temperature furnace. Then those combined materials in both cases go into
3357 a large chamber. It is certainly true of defendant's operation that residuum is drawn out of that chamber. The patent mentions the presence of the residue drawoff line and the valve but says nothing about it in the description of the process, but I think we can assume that that is intended to be used for the purpose of drawing off residue. The vapors go on over into the dephlegmator first referred to.

Q. Yet you say that in this Egloff process as disclosed in the Egloff patent it is not manifest that a part of the low boiling fraction, we might say, which

is passed through the low temperature coil is sieved out and constitutes a part of the feed to the high temperature coil?

3358 A. Well, in the first place I have difficulty in 1722 answering you on that because to me the process just doesn't work to crack oil, but it is clear that the intent of the patent is to mix these two streams of oil and deliver them into the expansion chamber to crack. That is the purpose of that expansion chamber there is to crack that oil. That is why he puts 135 pounds pressure on it, and you just couldn't get that oil to vaporize out of there with that pressure unless you were doing a lot of cracking in there.

Q. Well, assume you are doing a lot of cracking in there?

A. Well, I don't call that a sieving operation.

Q. No, not the sieving operation there but the sieving operation which takes place in your dephlegmator or the part—if your lightest material goes overhead and your heavier material returns through the pipe 23 and goes back to your high temperature coil, would you call that a sieving operation?

A. I am sorry, I misunderstood you. I thought you were referring to a sieving operation in the expansion chamber itself.

Q. No.

3359 A. I think you could very well call what takes place in the dephlegmator a sieving operation.

The liquid material which is drawn from the bottom of the dephlegmator, or which is intended to be drawn, at any rate, from the bottom of the dephlegmator, comes from the cracking and resultant vaporization of the oil from both of the heating coils, this cracking and vaporization taking place in the expansion chamber.

1723 It is my contention that the reason I don't get sufficient cracking or don't get cracking in the coil 6 is that the temperature given in the specific example is not high enough for a coil cracking operation.

3360 The specific example is the only process description in the patent.

I think if the man skilled in the art knew he wanted to crack in the coil 6 he could run to higher temperatures and accomplish cracking, or he could make the

coil longer. I don't think there would be any difficulty either to a man skilled in the art to design a low temperature coil to do what he wanted to do in that coil.

3361 We discontinued the vapor phase operation that we carried on at Skelly before they started measuring anti-knock properties by octane number, but I should say, it would be an estimate that the octane number of the gasoline which was made in that process would be somewhere in the neighborhood of 75 to 80 octane number. After discontinuing that process we did not obtain that gasoline having that octane number or approximating that octane number by running a Winkler-Koch process and adding ethyl fluid. I can explain to you what the situation was there. This high octane product produced from this high temperature vapor phase still was blended with other gasolines to make the gasoline which was marketed as the premium motor fuel. After we got the Winkler-Koch stills we used the Winkler-Koch gasoline as the other ingredient of the blend. Before that time we used the Jenkins gasoline.

1724 Now, after the still was shut down or before
3362 the still was shut down the company took a license with the Ethyl Gasoline Corporation for the purchase and use of tetra ethyl lead to make ethyl gasoline, and after that time the premium motor fuel was made by adding lead, adding this tetra ethyl lead to these other gasolines instead of adding the product from this special cracking still.

3363 I have forgotten the octane number of that gasoline which was made by the addition of ethyl fluid. The octane specifications of ethyl gasoline were changed from time to time, they have been gradually raised over the period of years. The ethyl gasoline had substantially the same octane number as the blend of gasoline from this high temperature vapor phase still, with the other gasolines; that is, our intent was to market a leaded gasoline which would have the same anti-knock properties as the blend gasoline which we had been selling for a premium previously.

3364 We discontinued that vapor phase process in either 1930 or 1931, I could not remember which year now. It has remained discontinued.

1725 *Redirect Examination by Mr. Von Holst.*

3364 At the time I left the Skelly Oil Company in 1938 they were operating a vapor phase still which we designed and put into operation in 1936.

The initial boiling point of an oil does not determine the temperature at which the oil begins to vaporize. That needs a little explanation because this initial boiling point we speak of is determined in a laboratory test procedure, and the initial boiling point is the temperature of the vapors which initially arise from the oil to pass over into the condenser in this test apparatus.

3365 Now the vapors at this time are always considerably lower in temperature than the temperature of the oil which is being vaporized in the little laboratory still itself so that to determine at what temperature the oil would begin to boil one would have to have a thermometer immersed in the liquid in the laboratory still to determine the temperature at which the vapors first begin to form, that is the temperature of the liquid at which the vapors first begin to form. And that temperature would be higher than the temperature that we call the initial boiling point.

Liquid vaporizes to an extent at room temperature, but of course very slow. That depends, of course, on the liquid and also what the volatility of the liquid is, but the boiling point of the liquid is the temperature at which the liquid will begin actively to form vapors. Now the vaporization which takes place at room temperature is brought about by the presence of air

3365 1726 over the surface of the liquid. If you have the

3366 liquid in a closed container so that the air is excluded, then there is some vaporization until you get a certain concentration of vapors above the surface of the liquid, and then vaporization stops, there is no further vaporization, but in an open vessel in a room the air currents keep moving the vapors away from the surface, and consequently you don't arrive at this equilibrium condition and the liquid continues to vaporize at a slow rate.

It is possible to crack in a once-through process in which the gas oil charge is mixed with recycled stock from a previous operation and get as much total yield

of gasoline as would be possible to be obtained from the recycling operation.

You get the same result by mixing reflux with fresh feed and returning it some later time as you do if you mix it and return it immediately.

1727 *Recross Examination by Mr. Hall.*

3367 The charging stock for this vapor phase operation that I say was installed in 1936 was gas oil of about 21 to 24 gravity with a boiling range from about 400 degrees up to about 650 degrees. As far as I know it is still in operation. That operated at different pressures during the period I was there, ranging from 500 pounds at the outlet up to about 700 pounds at the
3368 outlet. That was a recycling operation. The cracking was all carried out in a furnace coil at temperatures of about 975 to 980. I don't remember exactly how long the coil was but there was about 9000 feet of pipe in the furnace and it was split like the operation of the defendant's furnace, so that the oil traveled about half that distance. I did mention this 1936 op-
3369 eration in my direct examination. That is one of the stills which we installed at the Skelly plant. The pressure at the inlet to the cracking tubes was about 900 pounds, as I remember, 900 to 1000 pounds and the tubes discharged into a fractionating tower. It was really a combination vapor separator and dephlegmator; that is, the lower part of the vessel corresponded with the vapor separator and the upper part corresponded with the bubble tower of the defendants' operation.

Q. Then you did not have a separate separating chamber and that separating chamber going into a dephlegmator or bubble tower?

A. Well, it was just one tall vessel."

3371 That vapor phase operation was simply called by a number there. It was a unit which we designed ourselves. It was designed under my supervision. We
3372 only had this one unit. I am afraid I gave you a
3372 1728 wrong answer a while ago because when you asked me for the characteristics of the feed I was then thinking of the combined feed at that time, so perhaps I had better answer both questions now. The

fresh feed fed to this operation was a gas oil of about 25 to 28 gravity, having a boiling range of about 400 to 650 degrees; and the combined feed had about the same boiling range but a gravity of about 21 to 24.

1729 *Re-Redirect Examination by Mr. Von Holst.*

3373 We operated the Winkler-Koch units at times as a vapor phase operation; however, the vapor phase operation does not conduct all the cracking in the vapor phase. The oil is converted completely into vapor before it exits from the cracking coil in that type of operation.

1730 *Re-Recross Examination by Mr. Hall.*

3374 I could not give you all of the times when we operated the Winkler-Koch units as a so-called vapor phase; there were different periods that we operated the unit that we call No. 6 as a vapor phase operation in, well, I am sure we did in 1934 and 1935 and I believe some in 1936 also. There must have been some other times, but right now I can not identify those times. We did not do it continuously through 1934, 1935 and 1936; alternate operations. The purpose of that was to crack the particular kind of cracking stock which we had available which was suitable to that type
3375 of operation. The particular kind that we had which was suitable for that kind of an operation was this type of material which was charged to this other unit I mentioned, that is of that general character. That came from the operation of one of the other Winkler-Koch units. That was not pressure distillate bottoms from one of the other Winkler-Koch units. That was a gas oil, a stream withdrawn from the bubble tower as a side stream from one of these other Winkler-Koch operations.

The purpose of that was to get a better operation for handling that kind of stock, and also to make a higher anti-knock gasoline. It has been done since
3376 1936 on that unit which was built and put into operation in 1936. I think it was carried out on this No. 6 unit since 1936 to some extent, but I am not sure. I last saw this other single unit which I claim the par-

entage of a little over a year ago, at the plant of the Skelly Oil Company in Eldorado, Kansas. I am quite sure that that operation has been continued to date or approximately to date but I could not say
3376 1731 positively because I have had no direct correspondence about it. When I left they had either two or three Winkler-Koch stills which were not operating as a so-called vapor phase method, according to the so-called vapor phase methods. They had these four cracking stills at that time; three Winkler-Koch and this other fourth one which was built in 1936 and the charging stock in this 1936 unit was also taken out as a side stream from the bubble tower.

In these bubble towers, such as this bubble tower, each of those plates contain a body of oil and they can from any one of these plates take off a stream of oil. And that is what I call a side stream.

1732 DR. CLARENCE R. REIMAN, 171 Sargent St., Newton, Mass.:

Direct Examination by Mr. Thiess.

3379 I am a consulting engineer doing work with a num-
3380 ber of clients. I was graduated from the Massachusetts Institute of Technology in 1912, in the course of chemical engineering with a degree of Bachelor of Science; and after two years as an instructor in the chemical department I went to England and Switzerland for further study at the University of Leeds in England and the University of Geneva in Switzerland.

My studies at the Universities of Geneva and Leeds had to do with research in physical chemistry; and at the University of Geneva it had particularly to do with the redetermination of the atomic weight of bromine. I graduated from the University of Geneva in '16 with the degree of Doctor of Science.

3381 I came back from Geneva to Tech and I was on the instructing staff for one other year, and then the war intervened and I worked for the Bureau of Mines, and later for the Chemical Warfare Service on the gas defense, gas mask design, and things of that sort and

ended up as a Captain in the Chemical Warfare Service.

Then I went to Harvard Medical School for a
3381 1733 couple of years in the applied physiology department to continue some of the work I had started on the gas mask investigations. And then left there in '20—well, while I was at Harvard Medical School I spent much time with the New Jersey Zinc Company on certain engineering problems that they hired me for and made there the acquaintance of Mr. Catlin, a mining engineer well known, who was operating or endeavoring then to operate a shale oil education process in Nevada. I spent a summer there with him.

3382 As I left the medical school in '20, I became associated with the firm of Arthur D. Little Incorporated, of Cambridge, Mass., and remained with them for nine years; and during that period I was in charge of much of the research and the development work and there were two large, we called them, jobs that we had which concerned petroleum. One from '23 to '26 that concerned the development of a vapor phase cracking process, the production of the vapor phase gasoline as a by-product and that process, since we were particularly interested in the gases produced in the process and in the conversion of these gases to some of the higher alcohols, such as isopropyl, secondary and tertiary butyl and amyl alcohols and the like. Then at about the time that work ended our company took on a contract with the Magnolia Petroleum Corporation, a subsidiary of the Standard Oil of New York, for a period of three years and that was a fairly heavy contract for our concern.

3382 1734 At times we had as many as thirty engineers and chemists at work on behalf of Magnolia. I
3383 was in charge of much of this work and at times all of it. We were particularly interested in the several gasoline cracking processes which were then being licensed to the refiners and their fractionating equipment and their manufacture of lube oils, waxes and so forth.

At that time the Magnolia Oil Company had 90 or 100 of the Burton stills. They had also 100 or 120 of the coke stills and at the end of the coking still operation there is a certain amount of cracking and

they had just put in, in either '24 or '25, I forget exactly, two of the modern Cross units; and later while we were still connected with them they put in several more of these Cross cracking units.

At the present time I am not affiliated with anyone in the commercial operation of cracking and treating oil.

Describing rather briefly the characteristics and
3384 compositions of crude petroleum, crude petroleum contains the whole series of hydrocarbons from the very lightest ones, some dissolved gas and gasoline and kerosene and gas oil and lubricating fractions, and generally contains a certain amount of natural occurring residuum.

These various crudes all respond in the same manner to various physical and chemical treatment. Of course one crude might have much more of the light fractions than another, or one crude might have a large amount of residuum as contrasted with a small amount in another crude, and the treatment would vary in the amount in that manner.

3384 1735 They would all be distilled to separate their fractions but the actual treatment that one crude
3385 would receive in a refinery might be quite different from the treatment that another crude would receive.

For example, some of the Mid-Continent crudes and Pennsylvania crudes might be distilled to make kerosene, gasoline and a cut of gas oil, and then very valuable lubricating fractions might be next obtained, and finally there might be left behind in the still a heavy residuum, or as frequently happens these might cook right down until only the solid coke is left; whereas in running California crude, just to mention a product from some other crude, where the residuum present is high, the material would almost never be taken down to coke because coke would be such a large part of the total. Such a stock would not be preferred material from which to make lubricating oil.

Most of the crudes are dark in color; some are quite black. I think it is fair to say all of them are much darker than the distillates that are produced from them in a distillatory process.

3386 The characteristic component of crude which gives it this dark color is carbon. I don't mean pieces of

carbon, but I mean carbon combined with hydrogen and other materials, and as the per cent of carbon in such a compound increases, the compound itself partakes more and more of the nature of the carbon.

This residuum which is of high carbon content is
3386 1736 quite dark, whereas the gasoline and kerosene at the other end of the series are generally water white.

This tarry asphaltic component of the crude has to be taken into account in the commercial heat treatment of the oil. If an oil is clean, water white, without any apparent amount of this residuum present it can be distilled almost to dryness and leave but little residuum; whereas that amount of residue would be greatly increased if the tarry and asphaltic materials were present and if the crude were dark in color.

3387 To separate crude petroleum as it comes from the ground into its various components, the crude oil being a mixture of materials having a wide range of boiling points would be heated in some kind of a container and the lightest of these would vaporize first and might pass off and be condensed into gasoline, then kerosene, gas oil and the heavier fractions.

The types of stills that are used in this atmospheric distillation can be grouped into three classes. One, the simple batch still where a definite quantity of oil is put into the shell and is heated and the several fractions taken off one after the other until either the residuum or the coke is left.

Then, two, several of these shell stills might be operated in series with a fire under each of them, the temperature of the first being maintained at such a
3388 point that only gasoline comes over, then the
3388 1737 material from that still would flow as a liquid into the next still which would be heated further to a higher temperature and kerosene might be taken from that still, and there might be others to take gas oil or lubricating oil cuts until the crude had been reduced to the heavy residuum.

Then, third, there would be the pipe still where all of the crude, I mean all of the components of the crude would be heated to the same temperature in a continuous tubular heater and to such a point that considerable vaporization would occur, and then this mixture of vapors and unvaporized oil would be

allowed to enter some type of a separating chamber where the vapors would be taken overhead and the residuum withdrawn. These vapors could be condensed all at once but in general would pass through some kind of fractionating device so that two or more cuts or two or more of the overhead distillates could be separated, such as gasoline, kerosene and some gas oil as well.

Q. Now, I wish to refer you to Plaintiff's Exhibit 504, which shows the commercial apparatus used by
3389 Burton in the cracking operation. Will you please describe briefly how an atmospheric distillation would be conducted with this identical apparatus?

A. This, of course, shows a shell still with a vapor line 4 leading up to fractionation condenser 5, and the vapors from that fractionating condenser go overhead to the final condenser 6. The entire crude containing all of its naturally occurring components
3389 1738 would be placed in the shell of the still, perhaps half or two-thirds full, to allow for expansion; and then the fire started and the gasoline—of course there is some gas which might have been dissolved in the crude, would pass up the vapor line 4, and over to the final condenser 6. While this was occurring some of the kerosene would also be carried out with the gasoline vapors, that is the partial pressure effect you have heard about, and some of this kerosene would be condensed in the fractional condenser 5 and returned back to the still, thus making a somewhat better separation between the gasoline and kerosene than would have been the case had this partial condenser 5 been lacking.

3390 The gasoline would have been run to a suitable tank and as the operator found that the product was gradually changing in gravity, by experience he would know when to change his cut, and run the next fractions into the kerosene tank. Of course gas oil will vaporize with the kerosene and would be largely fractionated out in the overhead aerial condenser 5, and returned; and that would continue until the several products desired had been removed and the residuum alone was left in the still, when it would be withdrawn.

The pressure of this distillation process which I have just described would be atmospheric or at just

a pound or two above, just enough to push the vapors along through the condensing coil.

Q. Accordingly from the standpoint of the apparatus, what is the major difference between the apparatus as shown on this Plaintiff's Exhibit 504,
3390 1739 when the operation conducted therein is for the purpose of atmospheric distillation and when
3391 it is conducted for cracking?

A. Well, for an ordinary atmospheric distillation a crude oil would be charged and distillation would be carried on about as I have suggested and without pressure. For a cracking operation a distillate stock would be charged to the still and pressure would be maintained on the still contents, in this particular Burton operation on the condensing part of the apparatus as well, by means of suitable valves at the end of the process, so that the cracking would occur before distillation occurred.

The function of this pressure in the cracking operation is to raise the boiling points of the materials that normally would distill over as they would do in the atmospheric distillation, and holds them behind as liquids for a length of time sufficient to bring about the desired cracking.

I have stated that atmospheric distillation is conducted in tube stills. For the purpose of deseribing
3392 how these distillations are conducted in these tube stills, I have prepared the drawing DX 778. This drawing does not represent or picture a still on which I have actually worked. It was long before my day of working that this still was made. I made up the picture from some publication, in part, and a part
3393 out of my own mind. I have not seen this still in commercial use. The drawing is being used for the purpose of illustration and simplification.

3393 1740 This still (DX 778) shows a coil in a suitable furnace with a source of heating, and a pump for pumping the crude oil through this coil in which the temperature is raised to a point so that a considerable degree of vaporization occurs, and this mixture
3394 of oil and vapors passes into the chamber marked "Vapor separator." The vapors separate, of course, by gravity in the chamber and pass overhead to a fractionating tower, the residuum being drawn off from the bottom of the vapor separator.

In the fractionating tower these vapors undergo the action of dephlegmation, and in this diagram are shown three fractions, the uncondensed vapors taken overhead to the final condenser to form the lightest product or straight run gasoline; a cut from the bottom of the tower labeled "gas oil," and an intermediate cut from the side of the tower labeled "kerosene."

There would be some permanent gas made in an operation of this type. The crude itself in most cases contains a certain amount of dissolved gas and at the temperature of such a distillatory operation a small amount of cracking, a matter of two or three per cent, might be produced and that also produces some gas and this mixed gas, largely the dissolved gas and partly cracked gas, would be separated in the final unit of the sketch, and would be separated from the
3395 lightest condensed product, the gasoline.

The valve in the transfer line just before the vapor separator I will mark C. That valve would serve no purpose in the atmospheric distillation I have just described. It should have been open during that
3395 1741 operation.

That apparatus illustrated in DX 778 could be used for cracking. If the temperature of the oils in the furnace had been raised to a much higher point than that required for distillation only, a considerable degree of cracking would have taken place. If a clean overhead gas oil stock had been charged, the oil could have been entirely vaporized in this coil and the vapors themselves further cracked.

I say you would need a clean distillate for that pur-
3396 pose because, if you put a crude oil or some dirty material through, there would be a residue left behind, just as there would be in a coke still operation and that would cause immediate difficulty in the tubes.

There are other cracking operations that could take place in this coil. For example, valve C might be in part closed as a throttle valve and then that would put pressure, a back pressure on the oils and vapors in the coil and vaporization of much of the oil present would be prevented and the time factor could be obtained, besides considerable cracking would occur in these coils, and there would be present coming through valve C both the vapors and the oils, and they would

have their pressure reduced going through C into the vapor separator, and further vaporization would, of course, occur thereupon; and the residue could be withdrawn and the cracked products taken overhead.

Then the valve C might be left open and the valve, which I will mark D over near the separator of
3397 1742 the fixed gas and straigt run gasoline, might be kept partly closed, so that when oil was conducted through the coils and was heated the cracking heat would be picked up in the coil and some cracking would occur in the coils and the liquid oil at a high temperature could be held in the vapor separator for a considerable period to give the time factor.

This vapor separator then, of course, becoming a reaction chamber where much of the cracking occurs, the vapors going overhead and being fractionated and the residuum being withdrawn from the reaction chamber.

3399 The apparatus shown on the drawing DX 778 at the right of the valve would serve the same purpose in either the atmospheric distillation or in the cracking operations.

Q. Now, in both the cracking and atmospheric distillation operations which you have described, in connection with the drawing, DX 778, you have described the withdrawal of residuum from the vapor separator. What if any difference is there in the residuum thus withdrawn in these two operations?

3400 A. Well, the residuum withdrawn from the crude in the atmospheric distillation, of course, is that which naturally occurred in the crude as it came from the ground. Now in the cracking operation, particularly when started with a distillate stock as a charge, which contains no residuum, then the residuum withdrawn from the vapor separator is that which was formed in the cracking operation. The character of the residuum in those two cases might be quite similar depending, of course, on the particular character of the crude that was being charged.

3402 1743 The steps of the atmospheric distillation process which I have described with reference to DX 778 I found in an old patent to Benton, which we will discuss later, in 1887, and there was a description in the book by Wadsworth of a large plant on the

Pacific Coast very much like this, in 1912 which operated commercially.

3403 Q. Now will you please describe just briefly the temperatures and pressures that are used in these topping and distillation operations?

A. Well, in a shell still for topping, the temperature of the oil being heated would, of course, be somewhat higher than that of the vapors carried overhead but the temperature would rise in the vapor stream to something like 400 or perhaps a little more before all the gasoline had distilled over; and to 550 or 600 possibly before the kerosene had distilled. And if the material were taken down to coke the temperature would gradually rise as the lighter gas oils and the still heavier gas oils and some of the lubricating fractions came over and it might drop a bit at the end due to excessive cracking. And I think the vapor stream might get up as high as 700 or 750, around that.

3404 In a pipe still operation for topping, the oil would be all heated together, the light materials, of course, when it came time to distill would aid by their partial pressure effect the heavier ones so the maximum temperature attained might not be as high as the maximum temperature attained in the shell still or coke still distillation.

3404 1744 Q. Now, Doctor, you have described in your testimony how cracking as well as atmospheric distillation can be produced in the apparatus disclosed in PX 504 and in DX 778. Will you please discuss 3405 very briefly whether a certain apparatus would indicate the character of operation which was to be performed in said apparatus?

A. No, because in PX 504, the Burton still, the cracking operation that Burton described could take place in it, or an atmospheric distillation of crude could be made to take place in it. Also such an apparatus could be used for a dehydrating step in the treatment of crude oil; that would generally be done by closing one of the valves in the system, such as valve A, the still having in it the water and oil and raising the temperature until there was a considerable pressure, perhaps 100 pounds, and then withdrawing the fires or at least shutting them down a bit and then cracking the valve which would let the water

distill over without the bumping that occurs when crude oils are heated with water present.

3406 Then in DX 778 there are several operations that could be carried out. One is straight topping. Two, a vapor phase cracking operation on a clean distillate stock and at atmospheric pressure, or if preferred a pressure could be maintained during this cracking by partially closing valve C; or a tube heating tank cracking process could be carried out by heating the oil in tubes and allowing the bulk of the oil to remain behind in the vapor separator which would then become a reaction chamber, the whole system then being maintained under pressure. Or as some of the

3406 1745 patents of the late teens and early twenties stress, the pressure could be maintained away at the far end of the system so that the condensation as well as the cracking and the digestion in the digester would occur under pressure.

Now using the apparatus shown in DX 778, there are limitations as to the character of charging stock that could be fed to the apparatus if it was used as a

3407 cracking process. If it were used as vapor phase cracking process we would certainly have to charge a clean stock because that would necessitate the complete vaporization of the material within the tubes and, of course, if there were a carbonaceous product, heavy residuum products present, they would dry up on the walls of the tube and choke it.

Also, if all of the cracking is to be done in the tubes and with considerable vaporization which would immediately infer a high temperature operation, 900 degrees F. or more, then that would have to be a clean stock and for the same reason. On the other hand, a dirtier stock, a topped crude or any oil containing its own residuum might be fed to those tubes if the heating only were done there and not much cracking and if the main cracking occurred in the reaction chamber on this chart marked "vapor separator", and if that body of oil were maintained under pressure during a long enough time to permit adequate cracking.

I have referred to gasoline, kerosene, gas oil, fuel oil, and so forth, as products of atmospheric dis-

3408 1746 tillation. These products as used commercially all have changed from time to time. In the early days of petroleum manufacture when kerosene was the

desired product, the refiner of course had no very large market for his gasoline and the kerosene contained much of the heavier parts of what today we put in the gasoline fractions. And of course during the war in particular we did not have enough gasoline to go around and the refiners did just the reverse, they took some of the light ends from the kerosene and crowded those into the gasoline so that the end point was sometimes as high as 450 degrees F. In fact, the Navy specification gasoline at that time was 437 Fahrenheit. What was originally called gas oil was a narrow cut between the kerosenes and the lubricating oils, and yet in this case, so far, we have termed gas oil to take care of a range of materials that are much heavier than that and go over into and sometimes include lubricating oil. Yes, they change from
3409 time to time as the market specifications demanded it.

Q. Now will you give a very short resume of the history of cracking, particularly from the standpoint of the products which are ultimately desired as a result of this operation?

3413 A. Well, I suppose the first cracking occurred when the first individual distilled crude oil, he certainly cracked some if he distilled higher than the middle of the gas oil range. The first commercial cracking, of course, was to produce kerosene and no one produced any kerosene by cracking without making its quota of gasoline along with it; and that was done, of course, in the first instance at atmospheric pres-
3413 1747 sure and later under pressure. Then at a later date gasoline being the desired product, the temperatures and generally the pressures were again raised, but in making this gasoline and even today in making gasoline you make kerosene along with it; it is impossible to avoid.

I now want to refer to some of the prior art and I
3414 wish to refer to the prior art patent of Atwood No. 28448, DX 779. For the purpose of simplification I will use a chart (DX 780) which I have made of the apparatus as shown in the patent.

3415 This apparatus of the Atwood patent shows a cast iron shell still with a suitable setting and fire and is of particular interest to us because of the separating chamber which is placed above the still and above the setting, and which Atwood described in 1860 for the

dephlegmation of the vapors which he produced by heating the contents of his still.

3416 The vapors from the heated oils in the still are passed out through the vapor line marked "vapor," and after dephlegmation had occurred in the separating chamber the condensed or heavier vapors would fall to the bottom and flow back into the still through the line marked "reflux". The uncondensed vapors would, of course, pass overhead to the final condenser and receiver.

Atwood contracts what he teaches with the old art. He says in the old art the amount of kerosene produced from a given body of oil was increased "by repeated simple distillations"—That is near the bottom

3417 of the first column of the patent about two and

1748 a half inches up.

Apparently the art older than Atwood's time after they had distilled off the kerosene and some of the heavier fractions redistilled as a separate operation the heavier fractions obtaining a small amount of cracking and producing some additional kerosene.

He states then just at the bottom of the first column that "my process is a practical embodiment, and combination of two operations peculiar to these bodies in a process of continuous distillation—viz, first, gradual and continuous application of sufficient heat to the substance acted on to initiate chemical changes which result in the decomposition or breaking up of the heavy bodies and the formation of light and heavy oil vapors, and comparatively small amounts of fixed gases accompanied with deposition of carbon in the still."

3418 Now his new art is different from the old art in that it is, first of all, continuous. And reading from where I left off, in the second column:

"Second, a continuous separation of the light thin oil vapors and fixed gases from the heavier oil vapors, and continuous condensation and return of the latter to the sphere of action of the heat until the whole is broken up, or nearly so, or as much as desired, by exposing the eliminated vapors in a chamber or receiver of considerable capacity situate between the point of forming the vapors and the condenser to a temperature about the boiling point of the lighter vapors and below the boiling point of the heavier

vapors, so that the heavier vapors gradually liquefy and return to be broken up by further action of the heat, while the desired light products pass over to the condenser, where it is liquefied and separated from the fixed gases."

3418 1749 In that particular portion that I have just read, Atwood describes the dephlegmation of the vapors produced in his still and the immediate return of the condensed recycle to the still for further treatment, and the removal of the light vapors to a final condenser.

3419 As to the advantageous results that would be obtained as the result of this dephlegmation, Atwood particularly speaks about the conservation of heat, in the next paragraph, the middle small paragraph on the second column, where he says:

"This gives my process a great economical advantage over the former practice of successive plain redistillations, by which a further portion of thin oil has heretofore been obtained."

In other words, by putting his reflux back in hot he conserves the heat of this reflux.

The Atwood patent teaches something with respect to the time factor, on page 3, the first full paragraph, beginning here (indicating):

"From the above description it will be evident to those skilled in the art that the particular character of the distillate will depend on the degree of rapidity with which the operation is conducted within such limits as it can be carried on at all in the above described apparatus."

And then about three inches lower:

"But within the limits above mentioned the slower the operation is conducted the greater will be the 3420 change effected by one distillation."

That certainly indicates that he well appreciated in 1860 this thing that we have been calling the "time factor"; that is by carrying on the operation more slowly he keeps the body of oil at a cracking temperature for a longer time and produces an ad-

3420 1750 ditional quantity of the desired product, kerosene.

Returning this reflux to the still, as Atwood describes it, is a recycling operation. The vapors leave

the still, are condensed and returned again to the still as a clean reflux.

Q. Now what fundamentals are taught by Atwood in this patent which are used in modern cracking operations?

A. He teaches the dephlegmation of the vapors from the still; the return, the immediate return of the hot recycle to the zone of action for further treatment; and also an appreciation of the time factor.

I now refer to the patent to Rufus S. Merrill, re-
3422 issue 7096, DX 781. This patent was issued a long time ago, in 1876. This is concerned with the cracking of heavier oils to produce kerosene and at atmospheric pressure. He describes in detail in the first column of page 1 the ordinary distillation of crude oil and contrasts it with the cracking distillation. Merrill has an appreciation of the time factor. For example, in the middle of the second column, just about the middle of page 1:

"The fires are reduced under the still by damping, and the stream of oil flowing from the condenser is greatly lessened, the process being so conducted that the heavy oil remaining in the still is lifted in vapors, and again condensed in the still, and falls back, to be again and again vaporized and condensed, the lighter
3423 vapors which are formed by this process, alone passing over to the condenser and out at the outlet."

Thus he keeps his fires lower, he says, when he is cracking than when he was distilling—I will tie that in in just a minute—and teaches the dephlegma-
3423 1751 mation within his still of the heavier vapors which have not been sufficiently cracked.

For example, on page 2, down just below the middle of the first column "up to this stage," he further discusses the time factor very clearly:

"Up to this stage of the distillation the processes have been conducted precisely alike; but now the essential difference of the fractional distillation from the cracking process begins. Instead of now reducing the fires under the still, and so conducting the process of distilling that the cracking of the heavier oils left in the still will be the result, the fire is somewhat increased, and the distillation goes on rapidly."

Thus he hurries up the distillation when he merely

wishes to distill and he slows it so as to get a longer time when he desires cracking.

3424 These operations of Merrill and Atwood would be carried out at atmospheric pressure. The Merrill refluxing, although it is well described in his specifications, would not be as controllable nor as well carried out as that in the Atwood patent, which was earlier and which showed the use of what was then a reasonably good fractionating device known as the benzol tower.

Aside from that it has the same purpose and functions in the same way as in modern dephlegmators.

Q. Will you just briefly state what are the fundamentals that are taught in this Merrill patent?

A. Merrill teaches the cracking of heavier oils to produce kerosene and at atmospheric pressure. He describes well the refluxing, which is in this case entirely internal of his still, and he teaches an appreciation of time factor.

3425 1752 I now refer to the patent to Dewar and Redwood, No. 419,931 (DX782), issued January 21, 1890.

Referring to the figure 1 of the drawings, a long horizontally placed retort is shown in a suitable setting with a fire-box under it, and this retort leads out to the front of the setting where an enlarged dome can be seen with a pressure gauge and safety valve.

The vapor pipe leads from this dome to the final condenser and then to a receiver.

3426 In the operation of this apparatus Dewar and Redwood suggest charging the heavy oil to be cracked to the still and then, in superimposing on this body of oil a gas pressure, using refinery gas or natural gas or even air is suggested, and a maintained pressure on not only the heavy oil being heated and cracked but on the whole of the apparatus including the condenser and receiver.

The fires are started and the heavy oil begins to boil and vaporize, and the dome C acts as a dephlegmator, and certain of these heavier vapors which rise in dome C are condensed, and they fall back into the still for further treatment.

The lighter vapors pass over through the condenser to the receiver marked D2. The valve D5 is used to

regulate the pressure on the system. Through this valve the original gas to produce the original pressure was charged, and from this valve would be withdrawn any excessive amount of gas produced during cracking while the operation was under way.

3426 1753 Now, he says near the bottom of the second
3427 column, page 1, line 90, that solid fuel or liquids or gaseous fuels can be used, although of course the drawings indicate a grate for solid fuel.

The principal respect in which the Dewar and Redwood patent differs from the Atwood and Merrill processes that I have previously described is only in that the whole operation is conducted under pressure, including the condensation under pressure, which apparently was a considerable part of his invention.

Dewar and Redwood maintained the pressure throughout the system, the retort, the dephlegmator, the condenser, and even to and including the receiver, the pressure being regulated by the valve D on the gaseous space above the liquid in the receiver.

The product that was desired in the operation of this cracking process of Dewar and Redwood is like that of both Merrill and Atwood, which was the production of kerosene. Gasoline was not the desired
3428 product in 1890.

I now refer to patent to Burton, No. 1,049,667 (PX 514), issued January 7, 1913.

In this apparatus of the Burton 1,049,667 patent a charge of gas oil is placed in the still and the temperature raised until vaporization occurs, and the valve below the condenser marked 11 is kept closed so that as the still is heated and as vapors and gases are formed a pressure builds up on top of the oil and in the condenser. Then as this heating is con-
3428 1754 tinued the lighter products formed in the cracking reaction, which is then proceeding, pass up the vapor line 7 which acts as a modest fractional condenser. Some of the heavier products, unchanged
3429 products, let us say, from the still, would condense and flow back, and the gasoline vapors would be condensed in the final condenser and at intervals withdrawn into the receiver 10.

Since gas will be produced during this cracking

operation which will not be condensed, and since this would accumulate in the system, Burton teaches the removal of the excess gas so as to maintain this pressure constant with the valve 12.

The patent says on page 2, line 18, that the pressure that is maintained on the still during the operation is four to five atmospheres.

Burton teaches the charging of a clean distillate stock, on the first page, line 22, stating that after the naphthas have been removed:

"This leaves the illuminating oils, the boiling points of which range from about 350 degrees F. to about 600 degrees F., and the lubricating oils and waxes and, as residue, fuel oil and gas oil, with boiling-points ranging from about 600 degree F. to 700 degrees F."

3430 1755 I think, your Honor, he is describing the products from a batch distillation, or perhaps even a coking still, since he talks about the products that have a value, such as the gasolines, naphthas and illuminating oils, and then he skips to the lubricating oils and waxes, which are the heaviest ones of all, and then picks up again and has a residue, fuel oil and gas oil. In those days that was not the most desirable product in these distillations, and although it was an overhead distillate having boiling points from 600 to 700 degrees F. and was distilled from his crude before the lubricating oils, he calls it a residue, probably residue because he couldn't sell it with the other refinery products. Burton used this clean stock as a charging stock to his still, because it was available and at low price, and he calls it a residue, because he wanted to make more gasoline and because if he didn't use such a clean stock as that in a shell still where he furnished all the heat directly under the bottom of the shell, he would stop his operation that much
3431 sooner, because in the cracking of even this clean stock he produces a residue which eventually stops his operation and if he had added a material containing residue to his still when he started he would have stopped just that much sooner.

I would say from the teachings of the patent that Burton certainly appreciated that it was necessary to use a clean stock as a charging stock because he

taught bringing an end to the operation while he
3431-1756 still had 40 per cent or so of his oil still in place in the still. He had no trouble while the oil—at the start of the operation he put in his fresh charge but after cracking had proceeded to a point his troubles became apparent and he found by experience it was best to stop at about that 40 per cent point.

Q. What does Burton teach with respect to the product that he obtains?

A. Well, Burton spent several paragraphs in his specifications explaining what he wanted to avoid. For example, beginning line 30 on page 1:

3432 "But these attempts, while successful in producing gasoline, have invariably, so far as I am aware, as the result of lowering the boiling point, changed the general formula of the paraffin group ($C_nH_{2n}+2$) to that of the ethylene group (C_nH_{2n}), rendering the product unmarketable because undesirable by reason of its offensive odor, for the removal of which no suitable treatment has been found."

Burton was going to make a cracked gasoline and he was going to have to sell it in competition with the straight run gasolines of his day which were sweet smelling, water white, and he recognized that as an object, and he believed that if he condensed his cracked gasoline under pressure that he would in some way change the material so condensed back from this undesirable ethylene series to the paraffin series. Actually he probably didn't do that at all. He simply was giving a light cracking and the result was not very bad, as far as odor went, and a gentle acid treatment was adequate to make it entirely salable.

3433 1757 I now refer to the Burton patent 1,105,961, under date of August 4, 1914 (DX 783).

There are two drawings on this Burton '961 patent. The first one is identical with the earlier patent which we have just discussed.

The second one is almost the same as the first one, the chief difference being the lack of a valve in the line between the condenser and the receiver for the desired product.

In this patent Burton describes a method of producing a further amount of clean overhead distillate,
3434 in this case cycle stock, from which he can obtain

additional gasoline by cracking it according to the disclosure of the earlier Burton patent.

He accomplishes this by removing the roughly 40 per cent of residue from the shell of the apparatus of his first patent and carries out in this apparatus of the second patent an ordinary coking distillation. He takes overhead as clean vapors and condenses as a clean distillate most of the oily materials in those bottoms from the first cracking operation and leaves behind in the still, in the second still, the coke as residue.

Figure 1 shows the Burton cracking operation that is the same as the figure of the first patent. From that operation he withdraws the residue and charges it to the figure 2, which is an atmospheric distil-
3434 1758 lation to take overhead the vaporizable materials, and he suggests leaving behind only the
3435 coke in the still. As to whether this clean stock which is made from the cracked residue is used separately or mixed with the fresh charge that is fed to the original cracking operation, the patent says, on page 1, line 101:

"It is my practice, and the preferable one, instead of treating the contents of the receiver 20 separately in a still 3, as suggested, to mix them with original residue treated therein; though the result is the same in either case."

That indicates to me that he is willing either to charge his cracking still with this distillate produced in the atmospheric distillation of his residue or with a mixture of that distillate and the original gas oil that he charged.

The principal advantage that Burton expected to obtain by this treatment of the cracked residue, as taught in this Burton '961 patent, and of course did obtain, was an additional yield of gasoline from what
3436 otherwise was the residue from his gasoline making process.

From a study of these two Burton patents, in my opinion, it was necessary for Burton to discontinue the cracking operation when 30 to 40 per cent of the original charge to the still still remained in the still, because during his cracking he had produced within the still a quantity of residual hydrocarbons, tarry products, which gradually became more and more

solid as cracking progressed, and he ended up
3436 1759 with coke in his still, and particularly on his bottom. That, of course, insulated his still bottom and he had the possibility of hot spots and dangerous blow-outs, so he stopped before that time was reached.

Burton tells you in his patent 1,105,961, to what extent he expects to increase his cracking operation by the distillation of the residue and return of the clean stock to the cracking operation. In the second column of page 1, lines 85 to 90, he says:

3437 "This procedure is carried on until the original contents of the still 12 have been reduced to a condition of dryness, the distillate accumulated in the receiver 20 amounting to about 95 per cent of the charge in the still 12."

That actually says that he left behind in his atmospheric distillation as coke only 5 per cent of the residue which he charged to that still. That may be a bit optimistic. I would think he would have a little more than that. But that indicates that most of the residue he was able to convert into an overhead distillate which he used as a satisfactory charge to the cracking operation itself.

3438 I now refer to the Humphreys Patent No. 1,119,700,
3439 DX 784. I note this Humphreys patent is assigned to the Standard Oil Company of Chicago, which apparently is now the Indiana Company and with whom, of course, Burton was associated, and it appears that Burton and Humphreys were associated,
3439 1760 and that Humphreys made this improvement on the Burton cracking still, and that he used the long pipes 4, the sloping upwardly pipes, as a reflux condenser, or partial condenser to condense and carry back to the still the insufficiently cracked materials which otherwise would be distilled over with the gasoline that was made. And this was done so that the quality of the pressure distillate collected as Burton taught in the receiver after the final condenser would contain a higher percentage of gasoline.

This reflux operation described by Humphreys is exactly the same process as the reflux operation taught in the early gasoline making patents of Atwood, DeWar and Redwood. It has a controllable
3440 feature in that one of the two lines shown may be

cut out with a valve so that less refluxing will take place so that he can control in part at least the quality of the distillate. Except for that control feature, it is identical with the refluxing of Atwood and the earlier patents.

The reflux operation is just as essential in the manufacture of kerosene as taught by DeWar and Redwood and Atwood, as it is for the production of gasoline as taught by Humphreys and Burton, otherwise the desired products would be contaminated to too large a degree with heavier higher boiling constituents.

Now, in the operation of a cracking process to make kerosene or gasoline, the ultimate product, such as gasoline or kerosene, is not the only product which is made in the operation. A whole series of prod-
3441 1761 ucts from the lightest, such as non-condensable gas down to the heavy residuum, is made in any cracking process to make either gasoline or kerosene. There was, of course as I stated before, gasoline made in kerosene cracking and kerosene made in gasoline cracking.

When the desired product is kerosene, the gas would be separated in the receiver following the final condenser; and in making kerosene some of the gasoline would be too light to allow to remain in the kerosene, and some operation such as a steaming out of the very light parts would have to be practiced in order that the flash points of the kerosene produced would be within suitable safety limits for use in lamps and things of that sort.

I now refer to the patent to Edwards, No. 1,170,884, issued February 8, 1916, DX 785. This is a file wrapper reference.

3442 The apparatus can best be followed on the first page of the drawing in Figure 1. A suitable setting and furnace is shown and with sloping tubes marked 1 where much of the heat from this furnace is to be picked up. The upper ends of these sloping tubes are connected into a header 12 through which the oil would flow on the way through horizontal tubes 14 and back to the larger drum 8. There are a number of those larger tubes 14 as shown in Figure 2, which is a plan of the same apparatus shown as an elevation drawing in Figure 1.

3443 The liquids after arriving in drum 8 flow down through tubes 15 or tubes 17, there are two
3443 1762 paths, either directly to the header 13 or by tube 17, to the smaller drum 10, and then of course up through the tubes again for another trip through.

The vapor produced due to the cracking of the heavier oil in these tubes would rise through the line 21 and then through the horizontal pipe connecting the cracking furnace with the dephlegmating device shown as four horizontal drums with tubes through them. Air is forced through these tubes by means of the blower 28 at the top of the drawing so as to produce a certain amount of cooling and the heavier components distilling over are condensed in these four air cooled partial condensers, and the final product uncondensed leaving the last of the four through pipe 30 to the final condenser and into a suitable receiver.

The materials condensed in the four air cooled partial condensers may be withdrawn separately
3444 through the side line No. 36 with suitable valves shown in the drawing. Or the condensate from these four aerial condensers may be combined, or any one of them, or several of them used and allowed to flow into the horizontal pipe 34 directly under the four condensers, and then down hill to the charging line entering one end of the drum 10; then this charging line apparently, if you will follow it back, No. 23, shows a pump 40, and that pump sucks in the raw charge and pumps it through the system.

The process that is operated in this apparatus is stated on page 1, line 12:

3444 1763 "The apparatus is especially suitable for continuous destructive pressure distillation of relatively high boiling point fractions resulting from petroleum distillation,"

3445 That indicates that he was to use as a charging stock a distillate similar to the gas oils we have been discussing here, and that charge is pumped, as I said, through pump 40, in line 23, into one end of the lower drum 10.

Now I should have pointed out in discussing the apparatus, that each of these drums, the large drum

8 and the small drum 10, are divided into sections by means of baffles and that these sections are connected up through individual circuits down through headers 13 and the sloping tubes to header 12, and back again to the same section, the corresponding section in this drum 8.

Edwards does this because he realizes that his oils being cracked as they flow around and around in his apparatus become continuously dirtier and charged with residuum, and he teaches the withdrawal of that residuum at the far end, at least one end of the apparatus and withdraws it through pipe 24 from drum 8. This pipe here (indicating). And that pipe 24 on the next figure, Figure 3, is shown with a goose neck that is just turned down into the liquid so that
3446 it could be so withdrawn. Thus Edwards has in this heater, which looks something like a tubular boiler in his setting, a long path through which his liquids being cracked circulate. For example, to follow them for just a moment, they would come in as raw
3446 1764 stock through pump 40, enter into the first section of the drum 10, then pass up the sloping tubes corresponding to that section through the header and back to the first section of drum 8, and some of those oils would go down to that same first section in the drum 10. However, these baffles do not shut off the flow of oil from one section to another completely. Those baffles are shown on Figure 3.
3447 At the bottom of the baffle of the upper large drum is the hole shown as 18, where the liquid can flow through to the next section. The hole 19 at the bottom of the baffle in the lower drum is also shown for the same purpose. Thus Edwards circulates his material cracking around and around and allowing some of it to flow from one section to the next section and so on to the last one, and from the last section he withdraws his residuum.

Edwards points out on the first page, from line 25 to 40 that it was old in the art to heat heavy oils under pressure so as to produce these lighter oils but that he differed from that old art by making the operation continuous. On line 44, he says:

"For the purpose of enabling this work to be car-

ried on continuously I have designed a tubular still." sectionalized and so forth.

3448 He points out at the top of the second column that his particular arrangement permits of greater safety in the operation and the possibility of operating at higher pressures. And quoting:

3448 1765 "The apparatus is particularly suitable for economically and efficiently carrying on pressure distillation to a fractional degree only."

There is apparently no idea in this operation of carrying the residuum to too heavy a point.

Now the reflux which is condensed from the vapors in the aerial condensers, at the top of page 3:

"* * * may enter a common return line 34, which joins the supply line 23 and thus reaches the lower drum of the still," (Lines 65-66 at the top of the second column).

This of course indicates that that reflux, as soon as
3449 it has been condensed and while it is still hot, is returned directly to the inlet side of the system.

At the top of page 3, the first column, line 3, the raw oil

"* * * enters the lower drum, at the compartment at one end thereof, * * *"

And I will skip to line 13:

"The residue discharge line 24, preferably leads from the upper drum compartment of the last section."

But as this process apparently has two ends, he puts in his clean stock at one end and recirculates it with some of the residuum produced within the cracking process, and then at the far end withdraws his residuum.

Lest there be any doubt as to what he is making, he says on page 3, line 56:

3449 1766 "* * * for the purpose of producing gasoline, the aerial condensers should be so proportioned as to knock back all of the oil fractions coming over with the vapors having higher boiling points."

As to the condition of the hydrocarbons in his tube, Edwards states at the bottom of page 2, line 56:

"The still is thus divided into a number of small
3450 circulating units, bringing the oil into rapid and repeated contact with the heating surface of the tubes,

and allowing the vapor formed in each circulating unit to become disengaged from the liquid in the upper drum."

That indicates that he had considerable vaporization in the tubes of his cracking apparatus.

From the description of this process in the Edwards patent and the drawings, the type of operation disclosed by it is a bulk pressure distilling operation where a bulk of oil is kept at a cracking temperature and in which the largest amount of heat is put in in the tubes through which the oil is circulated by means of the thermo-syphon effect.

Summarizing the process steps, Edwards teaches the charging of a clean stock, such as gas oil, to his cracking unit; its circulation within the unit over and over and gradually builds up a content of residuum. He removes the vapors from the drum 8 at the top of his cracking unit and carries them through a dephlegmator, condensing the unconverted portions and carries the vapors of the final products on to a final con-
3451 denser, and returns immediately and while still hot the clean recycle condensed out of these partial condensers, and continuously withdraws the residuum from the far end of the process.

3451 1767 Referring to page 3 of the patent, the description beginning at line 103 reads:

"The overflow line 24"—that is the residuum line,—"through which the residue escapes from the still may lead to storage, or as indicated by the branch 42 may lead into or constitute the supply line of a second still, which may be in all respects like the first and is therefore not illustrated."

Now, without reading that further that teaches an alternative operation which Edwards had in mind and he proposed using this residuum from the first operation as a charge for another still, or even more stills beyond that, until he had reduced his residuum to "any desired degree of concentration."

Now that would differ from his first operation, this
3452 alternative operation would differ from his first operation in that he charges to the system a stock which is already dirty and although he mixed with it a clean reflux his charge is dirty when he starts and, of course, it gets to the end of the trip through the sec-

ond still it would be considerably dirtier than when it went through the first still; and if he carried that out, and if he puts it to any desired degree of concentration he would be in trouble somewhere along the line because this residuum would be accumulating to too great an extent.

I now refer to Smith patent 1,239,423, issued September 4, 1917 (DX 786). That is a file wrapper reference also.

This patent to Smith, quoting line 8, page 1:
3453 1768 "relates to certain improvements in the method of destructive distillation of higher boiling point compounds of petroleum and particularly distillates known to the trade as fuel oil or gas oil, having a boiling point of 500 degrees Fahrenheit and upward."

And just above that on line 6, he describes it as "an improvement in the manufacture of gasoline."

Now Smith, something like the Edwards patent we have just discussed, shows a bulk of oil in a shell still and with headers beneath the shell and with sloping tubes again fired very much like a tubular boiler; he pumps in his clean stock from the pump 11, through line 12, into this body of liquid in this still, and which circulates down through and along leg and header 15 and 16, up through the tubes and back through the header at the opposite end of the still.

The vapors from the still are carried overhead and condensed. He does not show any very important dephlegmation occurring between, and he has two additional features in his apparatus which are concerned with his invention. Those brushes 27 which are shown within the still are driven by the pully 28
3454 which apparently is at the end of a shaft sticking through the shell of the still, and the drive pully 29 and driven in such a direction that the lower part scrapes along the bottom of the still from the direction of left to right, the same direction that the oil is flowing, over the surface of the bottom of the still. He does that to scrape any deposit, as he says, from the bottom of the still and also to increase the rate of circulation of the oil through the still and
3454 1769 down to and then up through the sloping tubes.

Then the other feature of his invention is con-

cerned with the two filters marked 30 at the bottom of the drawing. He places in those filters a material like Fuller's earth and he withdraws from that lower part of the header 16 some of the residuum and uses first one filter while the other is being cleaned, using them alternately, he filters a part of this residual material through the filter 30 and takes out at the
3455 bottom a cleaned stock which he pumps with his fresh feed, the gas oil, back into the process.

Now he uses in this filter, not an inert substance like a wire screen or something of that sort that would pick out the pieces of hard carbon or coke which might conceivably be present, but he uses Fuller's earth which will do more than that. This residuum that we have all spoken about, asphaltines and what not, will attach itself to the Fuller's earth even though it is dissolved in the oil and will remain attached, "absorbed" the physical chemist says, to attach to the surface and stay in the filter. The refiner has used Fuller's earth for similar purposes; for example, in making lubricating oils before they are cleaned up and are fit to put in an automobile engine, or for other lubricating purposes, they must be cleaned of all trace of such residuum; and many of the lubricating stocks as they are made in the refinery have not been distilled and they contain the natural occurring residuum, and one of the methods by which this residuum has been withdrawn in commercial
3456 1770 operation was to contact the not yet cleaned lube oil with some Fuller's earth and stir it up for a period, later filtering off the Fuller's earth and the residuum staying with it.

Now whether or not Smith would get a clean stock from the bottom of his filter would depend entirely on how much Fuller's earth he used, how often it was changed, and the condition he kept the filter in, but he could take out from the bottom of this filter clean stock, bright in color, and he would then by returning to his system this filtered residuum get his clean charging stock. He thereby would permit his process to run for a longer time than if he just let all of the residuum that formed remain within the still as Burton had done.

3457 The Smith patent makes a point of velocity in a couple of places. On page 2, line 32:

"The brushes are rotated in the direction shown by the arrows in the drawing, thereby assisting in maintaining the circulation in the still, and also sweeping the bottom"—

And then a little farther down, line 45, still page 2:

"The mechanical agitation of the liquid in the drum by the sweeping action of the brushes facilitates rapid circulation and assists in preventing deposition of carbon in the apparatus."

On the first page also he mentions, on line 37:

"whereby so rapid a circulation is maintained during the process that the objectionable aforesaid carbon deposition on the heating surfaces of the still is greatly reduced."

Now in these processes that I have thus far discussed, namely, Burton, Edwards and Smith, the
3458 1771 hydrocarbons oils were all cracked in a bulk of oil maintained generally under superatmospheric pressure, the heat being applied either directly to the container of the oil or to tubes through which the oil alternately circulated on its way through the container.

Now in the oil cracking art there is another school of cracking in which a body of heated oil is not maintained in a tank to obtain this necessary time factor for the purpose of cracking the oil. There is another school of thought which might be described as the coil cracking school where all of the heating and all of the cracking takes place entirely within the coil.

I now refer to the British patent to Benton No.
3459 1922, of 1897 (DX 787). The figure 1 of the Benton patent shows an elevation of this apparatus, and figure 2 shows a plan of the coil in the furnace. It consists of a furnace and suitable setting for this coil through which the oil is pumped by the pump T at the bottom of figure 1 in a continuous stream through the tube, where it acquires all its heat and where the reaction is carried on. And this oil in the coil is under a pressure which, as Benton states on line 18 of his complete specification, is 285 pounds or more to the square inch. This pressure is maintained up to the valve G shown in the center of the chamber marked

C, and this valve is regulated by a handle which comes to the outside and the pressure is released at that point and the oil, which Benton suggests on line 21:

3460 "On the entrance of the liquid into the vapor chamber C which may be under pressure of one atmosphere, or which may be exhausted to any lower

3460 1772 pressure as desired, a rapid evaporation of the heated hydrocarbons is effected."

Thus apparently the oil largely is a liquid in the continuous tube and under pressure to prevent vaporization, has its pressure released at the valve G, and this oil sprays into the chamber C where the pressure is lower, evaporation rapidly taking place and the vapors formed passing overhead through a condensing box H, which is not very well described in the specification and what appears to be an ordinary coil condenser to the left of that, and he states in line 27, page 1:

"The heaver liquids not evaporated flow off at the bottom of the vapor chamber at *h*."

A 45 degree bend is shown at the bottom of the connection to the separating chamber where he withdraws his residuum.

Now Benton teaches no dephlegmation or fractionation of the vapors which he takes off from his separating chamber C. He condenses them all at once with the exception of the residuum which remains in

3461 the chamber and flows out through the bottom at *h*. In other words, his final product from this operation would be the desired cracked product, doubtless kerosene, together with all the recycle which he takes overhead and condenses, and he would have to make a separation of that kerosene from that recycle by a separate and independent distillatory operation somewhere else.

I would like to call attention to one thing in this patent, I mentioned it before, Benton also teaches the use of this particular equipment for an ordinary

3461 1773 atmospheric distillation for the refining of oil.

I stated that this patent issued in 1887, was the first reference I had found to the pipe still for that purpose.

On line 8:

"This invention consists in a method and means for

producing lighter hydrocarbons from the refuse of petroleum oil."

That is obviously cracking,—

"tar oils and other heavy mineral oils and of refining crude petroleum."

3462 And by the refining of crude petroleum he doubtless meant the straight distillation, and I am confirmed in that statement because again on line 33 he says:

"For producing refined oil from crude petroleum the process is performed in the same manner in the apparatus but under a lower pressure."

That indicates the use of this apparatus as a pipe still for ordinary distillation at atmospheric pressures of at least low pressures, of crude oils.

Summarizing briefly the process steps, Benton teaches the pumping of the crude oil through a continuous tubular heater under pressure, vaporization being prevented by that pressure largely at least until he reduces the pressure at valve G and in this vapor chamber permits the evaporation to proceed, the vapors to pass overhead and be condensed and the withdrawal of a residuum, the unvaporized portion through the connection at the bottom of the vapor chamber. I note that the bottom of this vapor chamber is situated directly over the furnace and

3463 1774 when I first looked at that I thought that was in a pretty hot spot for the withdrawal of residuum. In looking at the patent he states, on line 25:

"The vapor chamber C is heated to avoid the condensation of the vapor generated therein, which pass therefrom to a condensing apparatus H, in which they are condensed. The heavier liquids not evaporated flow off at the bottom of the vapor chamber at *h*."

Now he doesn't say to heat that vapor chamber to such a degree that he will cause cracking to occur in the draw-off line. He states that it is to be heated so as to prevent condensation and that is well understandable to a man working in the art that it must be lightly heated.

I think, myself, I would have raised that up a little higher out of the setting as it strikes me as being a little bit low. On the other hand, I look at this whole drawing as being entirely diagrammatic, certainly it is against all the rules of safety to stick a condenser

and outlet from it right beside the fire at a still, in any still setting, it is always removed to a distance.

Next I notice the coil itself, even in 1887 it would
3464 have seemed possible to have crowded a lot more tubes into that large space in the diagrammatic tubular heater shown in the drawing.

Now I refer to the British patent to Pielsticker No. 6466, of 1890. (DX 788.)

3466 Pielstick describes on line 20 of the complete specification an improvement in "the distillation of
3466 1775 hydrocarbons (and other oils) by means of which not only the operation of distillation is conducted in a continuous manner but also a lighter oil of one uniform gravity is obtained as a product." I will finish reading that, reading:

"obtained as the product of such distillation then the heavier gravity of the raw material subjected to distillation."

That teaches that this has to do with cracking since he is about to make a lighter oil of one uniform gravity from one of heavier gravity. He describes a con-
3467 tinuous process, and shows in the not too detailed drawings accompanying this patent, a tubular heater and mentions a retort which is not shown except as a little fraction of it in Figure 3. Actually he pumps the oil through the continuous coil where much of the heat and some of the cracking takes place, and then allows it to enter a retort which is also heated, and the vapors leaving that combined coil and retort are taken over to a condenser and condensed without any dephlegmation, without any separation of recycle from the final product,—he is getting the two things together—except that he teaches the withdrawal of the residuum from the retort itself.

Now this patent refers to an earlier Pielsticker patent, No. 1706, dated April 10, 1882, (DX 789) and he tells of the difficulties that he had in operating this earlier apparatus in carrying out the several processes which he discussed.

3468 Deviating for a moment, what this patent 1706 of 1882, DX 789, discloses, (Tr. 3473) is briefly stated in the second paragraph, beginning line 8:

3468 1776 "My invention relates:—Firstly to a continuous distillation of Fats, Oils, Glycerine, Rosins

and Hydrocarbons by forcing an intimate mixture of Fats, Oils, Glycerine, Rosin or Hydro-carbons and Steam by means of an 'Injector' through a coil, pipes or retort connected with a condenser and kept at the distilling point of the Fat, Oil, Glycerine, Rosin or Hydro-carbon under treatment."

May it please your Honor, the whole of this specification, with one exception, relates to the chemical treatment of these fats and oils for making soap, for
3469 making glycerine and what not; and in one case he explains that hydrocarbon oils may be put through that retort and permanent gas, such as illuminating gas, produced. That is the only mention a cracking in that 1882 patent, but that was very deep cracking and produced carbon and gave him trouble in his tubes and he made his invention in this No. 6466 patent of 1890 with an idea of remedying the troubles that he got into in his cracking coils.

He did that—his invention, as far as the coil is concerned in this patent of 1890, concerns threading the pipe through holes which he had made in a block of cast iron and then putting covers onto the end with semicircular passages to connect up the ends of these pipes, presumably with gaskets and with means of fastening it on tight. So that he took the tubes themselves out of direct contact with the flame to prevent local overheating and be able to crack oils in that coil without carbon deposition and in a uniform and continuous manner.

3470 The block of iron had a large heat capacity, it was a reasonably good conductor of heat. He had his
3470 1777 solid fuel fire as indicated by the furnace and if he heated one part of that block of iron too much the heat would flow along the iron and tend to make more uniform the heat the tubes received and therefore the oil within the tubes.

There are four places in this specification of the Pielsticker patent No. 6466 which indicate that Pielsticker intended to operate this apparatus as an oil cracking process. On page 2, line 22, "to produce also a lighter oil of one uniform gravity". That indicates cracking.

At the bottom of the same page, line 51:

3471 "In this case the cover 0 can be easily removed and

the pipes be occasionally cleared of the carbon deposited inside from the heated oil, by simply forcing an iron rod through the length of each pipe forming the coil."

This carbon deposition indicates that cracking was going on. If he had been doing only distillation, he need not have deposited any carbon there.

And then on page 3, line 6:

"I have found that passing the oil through the coil with great velocity I in a great measure prevent the deposition of carbon or heavy matter which would soon choke up the coil."

And then a little lower down, line 19:

"When it is intended to produce still lighter gravity oils or even permanent gas, for the production of which the temperature of the coil and the retort has to be kept higher and the distillation inside the retort conducted more slowly or retarded by means of baffle plates fitted inside the retort, a valve G may be placed between the outlet F of the retort and the condenser as shown in Figure 3."

3471 1778 This indicates that under certain conditions at least he planned on operating the cracking 3472 process under pressure and used valve G to maintain that pressure on the oil being treated.

As to the importance of his coil and furnace construction, Pielsticker says in the first paragraph on page 3:

"This construction of the heating coil is a matter of great importance, since it is impossible to clear an ordinary coil of the requisite length from any carbon adhering inside. Moreover the coil being loosely inserted in the block of iron or of refractory material B the whole length of the coil is permitted free expansion and the joints are in consequence kept tight."

This indicates that Pielsticker thought that he had made a real invention when he put this block of iron around his coil and, of course, once again in that 3473 paragraph he mentions that carbon does adhere and he may have to clean it out.

Q. Now will you just please summarize the process steps taught in this Pielsticker patent No. 6466?

A. He teaches heating the oil in a tube through which it is pumped continuously and in which the

cracking heat is applied and some cracking occurs, since he mentions carbon in the coil, and then allowing the oil and vapors to enter a retort which is also heated and from which retort he withdraws a residuum and carries overhead the vapors of his finished product, kerosene, and a recycle and condenses them together. He does not teach dephlegmation or the return of reflux in that patent.

3473 1779 Q. I now refer to a later British patent to Pielsticker, No. 1308 of 1891, (DX 790).

3474 In this British patent, No. 1308, of 1891, Pielsticker goes one step farther than in the earlier patent of 1890. He teaches here the continuous cracking of heavy hydrocarbon oil in a tubular heater and further heating in a retort, and then the dephlegmation of the vapors from that retort so that the heavier products, the recycle, are condensed and returned to the inlet side of the cracking tubes and the condensation of the desired product in a final condenser. Describing the apparatus which Pielsticker

3475 discloses in DX 790, it states on page 2, line 13, that the oil to be distilled is contained in tank A, shown in figure 1, and is heated by means of a steam coil P, or otherwise. From this tank the oil is forced by means of a pump C, or otherwise, into a coil D which is formed of a number of iron pipes encased in this block of iron, just like we have been discussing in the 1890 patent. From the coil D the vapors and oil produced by the heating and cracking of the oil in this coil enter the retort through the line G shown in figure 2, just above figure 1, and you will note that the retort is shown heated there as well as the cracking tubes.

Near the lower end of the retort is fitted a valve N for the removal of the tar or residue during the operation of distilling. That is shown in the figure 1 as well as in some of the others. It is shown

3475 1780 in figure 2. Above this valve N is shown a connection C, which is a steam inlet, and I am reading from line 32, "being connected with the

3476 tar outlet, in order to blow steam when the tar outlet is opened, which not only assists in the removal of the thick tar or the residue but more particularly prevents air from entering the retort, which

air would form a dangerously explosive mixture with the highly heated oil gases inside the retort."

That steam, it seems to me, might be useful if the valve hadn't been used for some time. Some of this heavy tar might have hardened up in it and the steam might blow it through While I don't see how air is going to get back into the retort during the operation of withdrawing residuum during a run, since the retort is under pressure, it would be true that at the end of the run the retort would still be hot and the oil being discontinued the pressure might be down, at which time it might be wise to blow steam out through that valve to prevent air from entering.

The valve R shown in figure 2 between the retort
3477 and the first of the three final condensers shown on page 3—I think before I read that paragraph on page 3 about that valve R, I would like to mention for the benefit of the Court that this patent describes no less than six entirely different kinds of operations that may be carried out in this apparatus. He throughout most of his specifications gives a pretty general idea of what it is all about, and beginning on page 3, each of the first six paragraphs describes a different operation, the first one being an
3477 1781 atmospheric distillation. The second one I will read in a moment. The third indicates what is to be done when a crude oil contains water and he wants to get rid of the water. The fourth goes back to his very early patent on the manufacture of permanent gas for city use.

He suggests that fats and oils may be distilled. His next paragraph is on distilled water or brine solution.

We are particularly interested in the subject matter of paragraph 2, page 3, which I will read, beginning line 7:

3478 "When it is intended to produce still lighter gravity oils, a valve R may be placed between the outlet of the retort I and the condenser U which may be kept open only so far as to create a certain pressure of the gases inside the retort, or such pressure may be created by means of a steam blast, introduced into the gooseneck Q, and blowing in the opposite direction to the flow of vapors which distill over from the

retort, or the gooseneck Q may be contracted at some point to a much smaller diameter by valve R or otherwise."

That is, that paragraph following the one just before it on straight distillation says that this is a cracking distillation which is carried out, and he is going to maintain pressure on his retort and on the coil, and he suggests three ways, one with the valve R shown, and the other by means of a contraction which is shown in figure 3 on the sideline from the dephlegmating dome marked R, or he suggests that steam can be blown backwards against the oncoming vapors. That is the third method.

3479 1782 On page 2, line 41:

"A dome P and goose neck Q connects the retort with a condenser. The dome P may be enlarged at its base forming a sphere, and may be provided at its lower end inside with a cup shaped projection T, into which any oil collects which may condense in the dome P and from which it may be returned into the retort I or into the supply tank A, through the pipe P'."

This dome is shown in figure 3 and is indicated as a much smaller device on the top of the retort shown in figure 2 and in figure 4. In that dome, figure 3 snows the enlarged base in the form of part of a sphere and the upright cylindrical section connecting with the constricted point in what Pielsticker calls the goose neck and labeled R, and which may be replaced by a valve, and it shows baffles situated in this dome.

The cup is shown marked T, and the P' is the tube which is to carry away the condensate from the dephlegmation action which is to occur in the dome P.

3480 The sides of this dome or condensing device of figure 3 are cooled only by the surrounding air, there being no discussion in the Pielsticker disclosure as to how else to cool them, but they are cooled because he states that the dome—I am quoting from line 45, on page 2—

"This dome may be provided with a number of baffle plates S, which force the vapors to come in contact with the inner surface of the dome P, where the heavier portion of them are caused to condense

and returning to the more heated surface of the retort, are reduced in gravity and finality distill over and condense in the condenser."

3480 1783 You will note that twice in that paragraph, part of which I read before, once on line 44 and once on line 48 he uses the word "condense", so he must be cooling that dome in order to bring about that condensation.

I now refer to a simplified drawing (DX 791) which I have made of this Pielsticker apparatus and
3485 process. This shows the several units of the Pielsticker patent arranged in order and with the dome having the enlarged base, this spherically enlarged base in position at the end of the retort.

I didn't feel that the dome with the enlarged base was shown anywhere except in figure 3 standing all by itself and that is why I had it placed there at the end of the retort where it could be seen in position.

3486 The oil to be immediately fed to the process is again held in the tank A where it is preheated with the steam coil. The pump C forces this through the continuous tubular heater and the block of iron labeled "heating and cracking tubes" and marked D, with a fire shown under it. In that coil much of the heat required for the process and some of the cracking is carried out, since Pielsticker continues talking about carbon depositions in his tubes.

Then this mixture of oil and cracked products, some vapors, goes over to the retort I, where it is further heated. That retort I holds a considerable body of the hot oils, and the time factor necessary for adequate cracking of the product is obtained by the use of this larger retort, this retort of larger capacity.

3487 1784 The vapors formed in the cracking, both those of the final product and those of certain not completely converted materials which are vaporized due to the partial pressure effect of the very light products present, rise up into the dome P, where a condensation of the heavier vapors is produced by the air cooling, as taught by Pielsticker, and the final product, as a vapor, leaves this dome P through the valve R and to the final condenser.

Now, in the Pielsticker patent that we have been considering this condensate caught in the cup. T

of the dome P can do one of three things. Apparently it can just spill over the lip of the dome and into the retort, since he speaks in one of these patents, at least, of again vaporizing it, or he states that it may be conducted through a pipe leading from the bottom of this enlarged portion of the dome and connecting with this cup T, and may be returned to the oil tank A as one alternative, and when so returned it would be a hot, clean reflux which would be mixed with the cold oil that must be continually supplied to tank A. And when that is occurring I
3488 suppose he could do away with his steam coils for preheating because the hot reflux would do the preheating.

Now in the British patent to Pielsticker there is a statement that says it can be put somewhere else. In this patent 1308 of 1891, on page 4 in claim 6, he speaks of the "annular cup, in which the heavier portions of the oil vapors condensed in the dome collect, and from where they can be returned into the supply tank, or into the heating coil, or
3488 1785 into the retort, substantially as described."

That is, they can spill over the lip into the
3489 retort, they can follow that connecting pipe back to the oil tank A, or as I have shown them being returned to the inlet of the cracking coils through a reflux pump, so marked, and with suitable valves in the two lines above so one could prevent their returning to the tank A. And this reflux pump is not discussed or disclosed in any of the Pielsticker patents, and that it seems to me would be an engineering expedient which any operator would use if he could find a pump that was satisfactory for the purpose. The pump is my addition. That is not in any of the patents at all. But he does say return it to the cracking coil, as it doesn't seem to me there would be much sense in putting it into the cracking coil anywhere except at the entrance of the cracking coil; certainly not at the outlet, because that would be no more than letting it spill over the lip and into the retort.

3490 This drawing refers to both the British patent and the United States patent No. 477,153 of 1892 (DX 792). The disclosures in those two patents, the British and the United States, are very closely the

same. In fact many of the paragraphs read the same. Apparently the reason we were more interested in the British patent was because that claim 6 said you could return the reflux from the dome P directly back to the heating coil. It is not so stated in the United States patent.

3491 Referring to the specification of the British patent to Pielsticker, he teaches that he desires to con-
3491 1786 duct a cracking operation in this process, on page 3, the whole of the second paragraph, beginning line 7 and ending line 13, which I have just read. That covers that entirely, the cracking under pressure to make kerosene. I don't think he says kerosene but that is what they were trying to make in 1891.

3492 Pielsticker teaches three methods of creating pressure on the system, the use of a valve R or a contraction in the pipe between the retort and the condenser as shown in one of the drawings, or the possible use of a steam blast blowing backwards against the vapors leaving the retort.

As to the function of the dome P Pielsticker teaches very definitely that it is used for the condensation of the heavy vapors. He says "condensed" in line 43, and in line 48. So that these heavy vapors will be condensed and returned to the zone of reaction for further treatment. The baffles S in this dome P are for the purpose of carrying the vapors out in contact with the surface, the inside surface of that dome P, which is to be air cooled so the condensation can occur.

In the prior litigation involving this Dubbs patent it was suggested by plaintiff's expert that this dome P was merely an entrainment knockout.

3493 Sometimes—in fact frequently—whe liquids of one kind or another are boiled there are particles of the liquid that are thrown out into the vapor space, and they might be carried by, entrained by a rapidly moving vapor stream and be carried along just as though they were vapors, and since those droplets of the liquid so entrained would represent the
3493 1787 material from which they were boiled it might in this case, for example, contain residuum going up through and, of course, not be a vaporized material and therefore not produce a clean reflux.

3494 There is no mention in the patent anywhere of entrainment or entrainment knockout, or of residuum being carried up in these vapors, or what not. Quite the contrary, in the paragraph on page 2, between line 40 and line 50, which I have read once and mentioned a couple of times, he specifically says "condense", and he says it twice in that garagraph, and he tells that in returning—I will stop there. He mentions it twice in that paragraph.

Now, you don't condense entrained droplets of liquid. They are already condensed. They don't require any further condensation. An entrainment knockout functions in general by trying to bring the entrained droplet, or all of these entrained droplets, in contact with a surface of material by continually changing the direction of the vapor stream carrying the entrained particles so that if it doesn't happen to strike the surface the first time its direction is changed it will strike it the next time, and the vapors would, in general, be lugged through a zig-zag path
3495 such as might be produced by throwing short pieces of pipe into a column. The vapors would have to pass in a zig-zag path up through and change their direction often, and would doubtless deposit the entrained material there on these many surfaces.

3495 1788 Now, in this dome of Pielsticker he shows baffles, the curved baffle at the bottom which tends to throw out to the side walls of the spherical part of this dome the vapors coming up from the retort so they will touch the sides and the other straight baffles would tend to hold these vapors out there. In other words, the direction of the vapors isn't changed. It is just held there constantly against this cold surface where there will be a heat-exchange taking place and where the condensation which he so specifically teaches would occur.

I don't believe that device would function well as an entrainment knockout at all. From my understanding of the description in this Pielsticker patent
3496 and the apparatus shown in the drawing, I don't think there would be any substantial entrainment from the retort I into the dome P. I think the baffles shown in these several drawings have something to do about that. I note that the baffles in these several drawings

are shown in more than one arrangement, particularly the last baffle toward the right of the retort. For example, in this 1891 patent in figure 2 the last baffle is shown somewhere near the middle of the dome P, and in the same patent on figure 9 the last baffle is shown a short distance to the left of the dome, and then in figure 4 just above it, it is shown just exactly at the edge of the dome. In each of those three that baffle touches the top of the retort.

Now, since these several Pielsticker patents are all closely alike I would like to check up on that on the U. S. patent.

3496 1789 In the U. S. patent, which is just like this
3497 last one. On figure 4 of the U. S. patent to Pielsticker, like one of the others I just mentioned, the last baffle is shown not in the middle but near the middle of the dome and touching the top, and on figure 6 of that patent the last baffle N is shown a long ways, a considerable distance, rather, to the left of the dome, and touches neither the top nor the bottom.

Now, there is one other figure also, figure 2 of this U. S. Pielsticker patent. The last baffle is at the left of the dome and touches the top of it.

In other words, in showing the arrangement of the baffles in this retort Pielsticker didn't seem to worry very much just where they were. He apparently didn't think it was very important and I am sure I don't either, except to point out this, that by one of two mechanisms the entrainment, if any, exists in these vapors above the heavy liquid in the retort L, being heated, which, of course, is actively cracking and which might throw up with a bubble of gas, which bursts at its surface, fine droplets of the liquid. Most of it, of course, settles back, but some of it might stay there and become entrained.

3498 I would like to point out that if that last baffle which is shown in one of the drawings—I had to make a choice and I took that one in this DX 791—that arrangement where the baffle touches neither the top nor the bottom of the retort would permit the vapors from both the right-hand side of that
3498 1790 baffle and from the left-hand side of that baffle to proceed along the top of the retort toward

the dome P. They could come from here up over there (indicating) or from here up over there (indicating), and the velocity of the vapors approaching the base of the dome would be somewhat less than they were if that last baffle reached up to the top of the retort. In which case any vapors that formed at the left would be locked and would have to get down under this baffle, and the velocity of vapors from the surface of the liquid where it was carried in that retort up through to the dome would be somewhat greater. On the other hand, if that baffle did reach to the top, that last baffle, near the dome, so that the velocity from the liquid surface of the oil in the retort up toward the dome were greater, an-
3499 other step would have been accomplished thereby which would be very important in the matter of removing such entrainment, because then all of the liquid, including all of the vapors produced at any point earlier in the process, would have to bubble down under this baffle and through the liquid.

Now, when you bubble a vapor containing entrained matter under liquid that tends to wash out that entrained matter very well indeed, and I will say again it doesn't matter which arrangement of baffles Pielsticker showed, he showed an arrangement, in any case which would keep entrainment at a minimum, and there would be no more to worry about in the Pielsticker retort than in any others.

3499 1791. Since entrainment, if any, would be at a
3500 minimum, and since this dephlegmating device is for the distinct purpose of condensing vapors, as Pielsticker so carefully points out, the condensate produced in that dome and collected in the cup T and carried back to the beginning of the cracking operation would be a clean reflux and it would be returned immediately and while still hot for further treatment.

3501 Q. Will you please state what the function of the dome P is and whether, with that function assigned to that dome, a man skilled in the art would insulate that dome with insulating material?

A. Well, this function assigned to the dome P in the patent is distinctly one of condensation, and not where you condense everything but where you con-

dense the heavy materials, and that adds up to one thing only, and that means a dephlegmation. In dephlegmation you certainly need cooling and you certainly need condensing, and if I were going to operate the Pielsticker retort and dome, or if anyone else was who was going to follow Pielsticker's teachings, he certainly wouldn't insulate it so that it wouldn't cool and he certainly wouldn't stick it down in the setting where the only cooling possible in his description could not bring about the condensation which he demands.

3503 The cracking described in the paragraph beginning at line 21 on page 3 is not the only cracking operation disclosed in the process of this patent.

3503 1792 I said before that there were six different operations described in this patent, and two of them are cracking operations. The one described in the second paragraph, lines 7 to 13, inclusive, is the one that I am sure we are interested in here.

The one described in line 21 to line 27 is for the production of permanent gas. I will read it:

3504 "If the manufacture of permanent gas or of very light oil is intended, the retort I is directly connected with a second coil D' similar to the first one D."

Without reading the rest of it, that indicates that he put his liquid oil through the first coil, heated it, cracked and probably vaporized it somewhat, put it into the retort, further heated it and produced vapors, and then brought those vapors out and put them through a second coil D1, which was heated so as to crack these vapors, and that would give him permanent gas such as he discussed in his 1882 patent, probably for the production of city gas.

What he means by very light oil in that same paragraph I don't know, except that whenever oil is used as a source of illuminating gas, and it has been used in some of our large cities, there is always produced a quantity of a light boiling material we call drip oil, or something like that, that may contain benzol or things of that sort.

The cracking operation disclosed, beginning line 21 on page 3, for the manufacture of permanent

3505 1793 gas is a very deep cracking operation, the only products being this gas and probably a heavy

tar which he doesn't mention, and this small amount of drip oil.

The one beginning line 6, obviously, thinking of the date 1891, was concerned with the production of a material, kerosene. Of course made at the same time was the gasoline, but kerosene was the desired product.

The return of the reflux collecting in the dome P to the inlet of the coil or the supply tank, as described by me and illustrated on the drawing, DX 791, is taught most specifically in the claim 6 at the end of the patent, "from where they can be returned into the supply tank, or into the heating coil, or into the retort, substantially as described."

3506 If the reflux collected from the dome T were run all the way back to the oil tank marked A, that hot clean reflux would, of course, serve to preheat the fresh oil entering tank A, and from which the pump sucks its charge to force it through the cracking coils, so that he would obtain by that means the same advantage that he would if he used the reflux pump which was not specifically disclosed in Pielsticker and which I have added to this drawing. He would obtain all the heat and have its immediate return of that recycle, and would have a combined charge of recycle and fresh stock fed to his cracking tubes.

I would think, for two reasons, that the oil tank A

3507 is merely an intermediate supply tank, prob-

3507 1794 ably not of any great size. He is not very specific about it. He simply says that A is the oil tank, and I think in one of the places it says that the oil for the process is contained in tank A. The tank A is a small, considerably smaller than the retort. On top of that, the inlet to the pump which withdraws oil from A and forces it through the coils is about half way up the tank A, so not more than half of the volume of the tank A would be available. I don't believe that Pielsticker was planning on making a run in which half of the small oil tank would be the only source of oil. Obviously there would be another larger bulk source somewhere which fed intermittently or continuously into this intermediate supply tank A.

Summarizing the process steps disclosed and taught in the Pielsticker patent 1,308 of 1891, the British

patent, Pielsticker teaches the cracking of a heavier oil in a tubular heater where the oil stream picks up
3508 much of its heat and in which some of the cracking is done, and with some vaporization, and then this mixture of materials flows into a retort which is further heated, producing further cracking and further vaporization, from which retort the heavy residuum is drawn off continuously. He teaches taking the vapors from this retort, putting them through a dephlegmation process, and carrying the uncondensed vapors overhead to a final condenser to make his final product, which is probably kerosene. The heavier materials condensed in the dome P serve as a reflux material, clean, which is carried back
3508 1795 to the entrance of the cracking zone to be mixed with the fresh oil charged and to be further cracked. This summary that I have just given applies to the disclosure of the U. S. patent No. 477,153, the same except that the U. S. patent doesn't specifically state that the oil may be returned to the entrance of the heating tubes other than by mixing it in tank A.

I now refer to the Hall patent No. 1,175,910 (DX 793) filed January 13, 1915, and issued March 14, 1916.

3509 For the purpose of clarity we have marked in red on this patent the Fahrenheit temperatures and the API gravities where specific gravities and other temperatures are given.

The apparatus shown in Hall 910 involves a cracking and preheating furnace. The spiral coil at the top marked 2 is the preheating coil, and the vertical
3510 tubes shown through the broken away part of the first upright unit show the cracking tubes, marked 4.

Oil for this preheating and cracking step is supplied by the pump 1 at the left-hand bottom up through the vertical line leading to the spiral preheating tubes. Leaving the top of the right of the furnace is a line through which the vapors pass downward through a valve 8. Now, that valve 8 is the pressure reduction valve. Hall teaches maintaining a pressure of some 75 pounds in the heating and cracking coils and reducing the pressure at the valve 8, so that I think he has 10 pounds the rest of the way through. I will check that in a minute.

3510 1796 The operation of vaporizing and cracking in
3511 the furnace is conducted as much as possible in the vapor phase. That is, he charges a clean stock and completely vaporizes it and does most of his cracking after the stock has been vaporized as vapors in the cracking tubes 4. Then on reducing the pressure at valve 8 he permits these vapors to enter the bottom of his first dephlegmator marked 9. Now, that dephlegmator is shown with packing, which he describes as optional but which may be cut up short lengths, pieces of pipe thrown in helter-skelter.

He teaches cooling in that dephlegmator. He has a —not an insulation jacket around it, but a cylinder of metal, apparently, around it, which is an air jacket so that air will rapidly circulate up through and bring about this cooling, and he collects at the bottom of that a heavy residue which he can draw off through line 12.

3512 The vapors which are not condensed in this first tower, first dephlegmator, rise to the top and then go down to the bottom of the second dephlegmator, which is similar to the first, and further cooling is provided in the second dephlegmator, condensing out the heavier materials, which may be withdrawn through the goose neck 15, which he calls a light residue for a recycle, and the vapors from the top of that second dephlegmator go to an auxiliary separating tank 16. Anything which is condensed in that he puts back into the lower section of his second dephlegmator, through the line 16A, but the vapors leaving that separator through the line just above the number 16 consist of his permanent gas and his
3512 1797 desired product, or motor fuel, which he runs over into a compressor.

Now, if you please, he might just as well have put a final condenser at that point insofar as anything that we are interested in in Mr. Hall's disclosure, as I conceive it. He felt that if he compressed the condensed gasoline along with the noncondensed gases up to some 90 pounds or more than he would get a re-
3513 action between these gases and the gasoline, and he wouldn't have so much trouble cleaning them and making them fit for sale, and so on. He was still worried about this fact that vapor phase cracked

products had a color and odor, and so on, and he figured that he would get a special motor fuel by condensing them after he had again put them under pressure by this pump, but I don't believe we will be worried very much about the Hall process after the vapors leave the second dephlegmator, which may just as well have been condensed in the final condenser.

For the purpose of this case the vapors leaving the line from the top of the tank 16 would normally flow through a condenser to a receiver, the final condenser to a receiver.

Referring to the patent, page 1, line 86, Hall refers to the process at that point:

3514 "Cracking an oil—(which may be crude, 'gas', fuel, lamp or almost any distillate that in itself has a range of boiling temperatures that would not permit its use as a fuel in the ordinary automobile engine)—in a continuous tube of small size, one to three inches, and of sufficient length, at an average temperature of from 540° C. to 600° C. on the exterior of the tube and under pressure preferably of about 75 lbs. per square inch."

3514 1798 Those temperatures, 540 and 600 degrees Centigrade, are shown on the margin in red, at 1004 and 1112 Fahrenheit.

The whole of the first column is concerned with the product, the gasoline, that Hall expects to obtain. He was one of the earlier operators in this field to appre-
3515 ciate the advantage of an anti-knock gasoline. He points out that his motor fuel, when used in an engine—at line 19—"knocking does not occur even with the spark advanced, to so great an extent as with ordinary gasoline."

In other words, by carrying on such a high temperature operation as Hall describes he produced a gasoline which didn't knock as much in the automobile engine as the ordinary straight run gasoline.

He makes a few comments at the bottom of the page in column 1 about the fact that he can make his cut at a higher temperature and a higher end point than competing gasolines of his day. Neither of those end points are very high. They are lower, all of them, than we use them today.

Then at the top of the second column, about line

60 to 70, he explains his theory. He expects to get
3516 this endothermic reaction when he compresses his gas with the condensate to get this improved motor fuel.

The statement beginning at the last line on page 1, column 1, and going over to the first two or three lines of the next column, reads:

3516 1799 "A distinguishing characteristic of the new fuel is that it contains a proportion of unsaturated hydrocarbons which proportion will naturally vary with the oil used in its production."

In other words, the highly unsaturated product which Hall makes and which Burton said he did not want to make, these olefine products which had a color and odor that Burton didn't want to make, are the very things, of course, that Hall is making here and is talking about, and which to a considerable measure are responsible for the anti-knock qualities which he obtains.

With reference to the condition of the hydrocar-
3517 bons in the Hall cracking coil, on the second page, about line 95, page 2, line 95, just above that, I will read:

"In the coil 4 the oil is partially cracked and there is produced a considerable amount of gas which would remain as permanent gas under ordinary conditions. From coil 4 the gases and cracked oil in the state of vapor pass in the direction of the arrow through pipe 7."

In other words, he plans on pretty much completely vaporizing his oils either in the vaporizer or in the first part of his cracking tubes, and most of the cracking is done after vaporization in the vapor state, known as vapor phase cracking. That cracking is performed in the coil 4. The hydrocarbons after they leave the coil in the furnace pass through the pressure reducing valve 8 and then into the very bottom of the first dephlegmator marked 9.

3518 The release of pressure produces a small amount of cooling, but the main cooling is, of course,
3518 1800 obtained from the air cooling provided for with the space between the jacket and the walls of the dephlegmator.

The vapors, of course, enter this first dephlegmator at the very bottom. I think there is some importance to be attached to that. I don't see how that line lead-

ing from valve 8 to the bottom of the first dephlegmator could have been shown any closer to the bottom by the draftsman if he tried. It certainly is within a matter of two or three inches of the very bottom. It seems to me that has some importance because it indicates that that is where Hall meant it to be. He wanted the vapors entering that dephlegmator to pass the full length up through the chamber, which he shows practically filled with this packing. Now, if he produces, as he says he does, the condensation in that first dephlegmator, and he teaches specifically reducing the temperature of the gases.

3519 I am reading on page 2, line 113, "reduced down to about 325 degrees Centigrade." That is 617 degrees F. At that temperature he would have produced a considerable amount of condensate in that first dephlegmator, and that condensate will flow down over the packing of the dephlegmator and accumulate, to a certain degree, at the bottom, and be withdrawn through the goose neck 12.

The condensation of this material which Hall describes as being withdrawn at 12 is a heavy residue. The condensation of this material will, of course, serve to wet with an oil film the surfaces of all this packing which is part of this dephlegmator, so that any materials in the vapor stream leaving the

3519 1801 cracking tubes and which enter at the very bottom would have to pass up through a tortuous passage and have their direction changed a great many times, and get into contact with these many surfaces wet with oil, so that any heavy residual tars or what not, that may have been produced in the cracking operation will be washed out by this inti-

3520 mate contact with the wet surfaces of the packing in this dephlegmator 1.

If there were no packing in there and if you reduced the temperature to the same extent and would, therefore, of course, produce the same amount of reflux falling down through that tower to be withdrawn down at the bottom as a heavy residue, that material would condense largely at the top of the dephlegmator where the cooling had had a little more time to act, and that might fall down a droplets of condensate throughout

the mass of vapors, something like a shower, and this would tend to wash out any heavy tarry matters that might remain suspended in the stream.

Of course I feel that the fact that the tube from valve 8 to the bottom of this first dephlegmator being set so low offers one other opportunity for cleanliness in the later steps of the process, because that
3521 must mean that the vapors coming from the cracking tubes are required to bubble through some liquid, heavy liquid, hot liquid, at the bottom of this tower 1, and I am very sure, from my own experience, that when vapors as hot as these and that have been cracked as hard as these are caused to bubble through a depth of this heavy residue, this tarry, sticky material, that they become very well cleaned of any entrained material, any tarry matters which may have come over from the cracking tubes and enter the bottom of this dephlegmator No. 1.

3587 1802 The Hall patent 1,175,910, DX 793 teaches the nature of the product which is withdrawn from the first dephlegmator No. 9 at the bottom of page 2, line 118:

"The portions of oil not volatile at the temperature of about 325 degrees Centigrade"—that is 617 degrees Fahrenheit—"condense in dephlegmator 9 and are extracted from the bottom by way of a pipe 12 in the form of a so-called 'heavy residue' of a gravity of about 1.0."

That 1 is 10 degrees Baumé.

The vapors entering the bottom of this first de-
3588 phlegmator from the coil are very hot, somewhere up around a thousand to eleven hundred degrees at the top range, and they are cooled in this dephlegmator so that a considerable quantity of the vapors are condensed to liquids, and the condensation, of course, progresses on the way up through the tower and is greatest at the top where the tower would be cooled; and the liquids that do condense run back over the packing zone in the tower and come into concurrent contact with the very hot vapors still entering the bottom, so that dephlegmation results. Of course, there is much more liquid in the top of the tower than there is in the bottom because of the reheating of the condensed liquids by the hot gases down toward the

bottom and the amount of liquid running out of the bottom is, of course, smaller and very thick and heavy, as this 10 degree Baumé heavy residue indicates.

All of the cracking in this operation of this
3588 1803 Hall process is, of course, performed in the cracking coil marked 4 in the furnace. Regarding the operation that is to occur in the second de-
3589 phlegmater No. 14, Hall teaches at the bottom of page 2, I will read:

"The more volatile portions pass on through pipe 13 in the direction of the arrow and through a similar dephlegmator 14 where the temperature is reduced to the point where it is desired to make the final 'cut', usually about 180 degrees Centigrade"—356 Fahrenheit—"the consensable portion being extracted by way of a pipe 15 from the bottom of the dephlegmator 14, said residue being termed 'light residue'. This residue is usually of a gravity of about 0.880"—that of 29.3 degrees A.P.I.—"and is used as raw material for a second run through the cracking coil 4."

In that statement, Hall does not specifically state when the light residue is to be returned. He says "For a second run through the cracking coil." He could, of course, put it in a tank and let it cool off and use it the next day or the next week; it would be a good stock for that purpose. He could run it into a tank from which the gas oil or other charge for
3590 his process was being pumped, so he would thereupon pump a mixture of the raw charge plus this light residue. Of if he had a pump available, he might put the pump on the light residue line and pump it directly back through the coils along with his crude which is also being pumped. This would have to be a hot oil pump and he might have had difficulty in those days finding one.

3590 1804 The drawing of the Hall patent shows two dephlegmators packed with short pieces of pipe. Hall teaches that this packing in these dephlegmators is optional. He says that it is preferable—on page 2, line 105:

"the gases are permitted to expand into the dephlegmator 9 fitted with an air jacket 10 and prefer-

ably filled with short pieces of pipe or kindred shapes or the like", and so forth.

I would say that it was up to the operator who was carrying out this disclosure of Hall as to whether he filled his dephlegmator with such a packing. Hall, in this patent on page 2, beginning with line 113,
3591 says regarding the carbon thrown out in the two dephlegmators:

"Carbon is thrown out in large quantities by the expansion of the gases and collects on the filling material in this and the succeeding dephlegmator."

This carbon that he speaks about, I think we will have to consider that he means not only carbon particles but heavy tarry materials, the language of the day when carbon was used in this art covering both classes.

Next his statement is not definite on three points. I want to make this clear because I am sure this will be an issue in the treatment of this patent. That carbon is thrown out in large quantities. Now Hall does not explain what he means by "large quantities", and in vapor phase cracking it took a very small quantity to produce trouble. In a process such as Hall's, where he was completely vaporizing, a few hand-
3591 1805 fulls of carbon would close down his process; whereas, in the process where most of the crack-
3592 ing was done in a place other than the tube, in this fireless cooker analogy which Mr. Smith made, carbon can be thrown out in the matter of tons and not give any trouble at all. Thus I would think that his "large quantities" meant large quantities as far as the operation of the type he was conducting was concerned and should not be confused with anything like tons.

Then he does not say anything about the distribution of that carbon and the amount that is going to be found in the first dephlegmator and the amount that is going to be found in the second dephlegmator. I am very sure myself that most of it would be in the first dephlegmator. I do not see how it could be argued differently. That may be a matter of half a dozen handfulls in the first and half a handfull in the second. I have no way of knowing that, but that would be my idea.

Then I am thoughtful too as to whether or not Hall made any tests to determine whether there was carbon in the second dephlegmator. I am going to admit
3593 that I think there probably was some in the second dephlegmator but Hall does not say he tested it and found it so.

I mention that because I think that most of us that have worked about cracking equipment and in the fractionating and dephlegmating end, have noted that black materials accumulate in there from time to
3593 1806 time. That is supposed to be the clean end of the system too. And that these dephlegmators and fractionators have to be cleaned, not every run but every few runs.

I have seen the excellent bubble towers that were on the Cross units in the Beaumont Refinery of the Magnolia Petroleum Company of Texas cleaned and they were black on the inside. I recall one time in particular when there was a manhole cover that had been taken off the side of that tower, some little distance up perhaps 15 feet or so, it was on the ground and it had a heavy black adhering coat on it. And I scraped off a piece with my jack-knife and put it in an envelope and carried it in to the office and later ignited it and it burned. There was a large amount of dark colored ash, and there was a strong sulphur smell from it. I did that because I considered that
3594 there was a considerable amount of iron sulphide mixed with the black deposit on this bubble tower, and that was a simple way of checking or proving that such was the fact. Iron sulphide is black. It is formed at the temperatures that might exist in such a bubble tower. It is the reaction between the hydrogen sulphide gas and the iron or steel of the apparatus. Most of these oils contain a certain amount of sulphur or sulphur compounds and at the cracking temperatures a considerable quantity of that hydrogen sulphide is formed. I mention that only because I can conceive of Hall noting on the inside of his second dephlegmator a black deposit, and an honest
3594 1807 fellow he just puts it down and reports it as carbon. I think he doubtless found a black deposit in the second dephlegmator. I think some of it was doubtless carbon, and I am reasonably—

Mr. Haight: I don't think it is proper, if your Honor please, for a witness to speculate as to what
3595 a patentee, whose patent is offered as prior art, may think that it is or what he may have found. His patent speaks for itself.

3597 The Court: It may go in, but I think I will let it go in under the rule and I can determine then perhaps later whether I should consider it or not. I am not certain now.

Mr. Thiess: All right.

Testimony under the rule:

Q. Do you remember where you left off, Doctor?

A. Yes. To be sure Hall calls this material carbon, I do not think that we are stretching any point at all to say that that meant in those days carbon and carbonaceous residue. Certainly it means something besides atomic or molecular raw carbon.

Next we have heard testimony earlier in this case that bubble tower dephlegmators corresponding to the second dephlegmator of Hall, as to function at least, contained carbon but it was not pointed out in that testimony that the reflux so obtained from such dephlegmator that contained deposited carbon was of itself unclean or dirty. And I think you
3597 1808 can read right in the patent here that Hall says
3598 that same thing. He says carbon is in the first and second dephlegmators, and I have said before and I will say again, I am very sure that probably there was some if you run the process for a long enough time you will certainly have some.

And then he states that the residue which was withdrawn from this second tower "is used"— and I am quoting "is used as raw material for a second run through the cracking coil 4." He did not say it could be run, if you want to. He did not say it might be run. He says it is run. I think that Hall meant that he used that material regularly to re-run it through the cracking coil.

Now, may it please your Honor, Hall is discussing a coil cracking process in which practically the entire body or stream of oil started through that continuous coil is vaporized. If he put residue, and I mean by that residuum material, into that coil it would be left behind and he would coke up and he would not

have an operative process. He says this light residue from the second dephlegmator is used as raw material.
3599 That is a flat statement. And that despite his other statement that he found black deposit which he specifically called carbon, in the second dephlegmator.

Mr. Thiess: Q. Now will you please summarize the operating steps of the process as taught in the Hall patent.

A. Hall teaches the cracking of a heavier oil
3599 1809 in a furnace composed of a preheating coil and a cracking coil, and under a pressure of 75 pounds per square inch, and at a temperature meas-
3600 ured in the furnace between the coils between 1000 and 1100 degrees Fahrenheit, so that he obtains with his distillate oils practically complete vaporization and does most of his cracking, of course, in the vapor phase.

He reduces his pressure through a reducing valve to approximately 10 pounds per square inch and passes the gases from the cracking coil up through a first dephlegmator which he cools with air cooling, condensing and refluxing within that tower so as to produce at the bottom, and which is drawn off, a residue, a heavy residue very tarry the 10 Baume which, of course, is not reused in that system.

The vapors from the top of the first dephlegmator enter a second similar dephlegmator at the bottom where you have further cooling to produce a light residue which is his reflux material and which he does return to the system.

The uncondensed vapors from the second dephlegmator could pass to a final condenser directly as have most of the processes we have considered, but Hall
3601 chooses to recompress them so as to obtain endothermic chemical action, as he calls it, between these gases and liquid and produces an improved motor fuel.

If the light residue withdrawn from the dephlegmator 14 were not immediately returned to the
3601 1810 process. Hall would, of course, lose the economic value of the heat contained therein and of course would have to provide additional equipment and labor to heat it up to that point when he reuses it.

The Hall patent being cracking primarily in the

vapor phase, the product from such a vapor phase process would be yellowish in color and would have a strong odor. I have had experience with the color and odor characteristics of vapor phase cracked gasoline as compared with gasoline made in low tempera-
3602 ture cracking operations. In the early twenties in the laboratories of Arthur D. Little, Incorporated, where I was employed, we built a plant out in the back yard and developed a vapor phase cracking process, and after perhaps a year of small scale operation we enlarged it to a size where we put 25 barrels a day of a 32 to 35 gravity gas oil through a heater at about 1100 degrees Fahrenheit, and produced a vapor phase gasoline. That was an incidental part of the total process that we were working with, since we were particularly interested in the gases produced, but this gasoline we did treat by a number of ways endeavoring to make it water white and suitable for use as a motor fuel since, of course, in a commercial operation involving these several steps that would have to be sold as a byproduct. And that gasoline was yellow and it did have a strong odor, and we found methods of treating it where it was satisfactory for running in the cars of the
3602 1811 men concerned, and in test engines that we operated to determine the anti-knock power and
3603 things of that sort. And during that period we obtained cracked gasoline,—toward the end of that period we obtained cracked gasoline from the Beaumont Refinery of the Magnolia, that was straight Burton cracked gasoline, and I can mention that specifically because I was then familiar with it and that was not of that color and did not have that strong odor, and of course was much easier to treat than vapor phase cracked gasoline. There was no gasoline sold from this small operation that I have just described that was carried on at the Little laboratory in Cambridge, but in '25, I guess it was in '25, we built a larger plant at Tiverton, Rhode Island, where 250 barrels a day of gas oil was charged to make this same vapor phase gasoline, and the alcohol and other materials that were prepared from the cracking
3604 gases; and that material was sold after a treatment to make it not as water white as the straight run gasoline, but at least saleable in appearance, and that

was sold as a material for blending with other gasolines to raise the anti-knock value of the blend.

It was sold, I think, almost entirely to the Borden Remington group who had a large number of filling stations in the Fall River and Providence District.

The anti-knock value or the anti-knock property of gasoline to-day is of course one of its very im-
3604 1812 portant characteristics. The premium gasolines to-day are all of high anti-knock and the third rate gasolines today are frequently the straight run gasoline which in Burton's day was the prize product. The straight run gasoline as a rule, of course, depending in part on their source, have a much lower anti-knock value than the cracked gasolines.

3605 I think it is fair to say that, other things being equal, the higher the temperature of the cracking the higher the anti-knock value of the gasoline produced.

3606 I now refer to the patent to Biddison and Boyd, No. 1,345,740, DX 801, filed February 15, 1918, and issued July 6, 1920.

3607 The file wrapper of this patent is DX 802, this patent having been filed prior to and issued after the issuance date of the Dubbs patent.

This patent of Biddison and Boyd describes an improvement in the distillation or treatment of petroleum for obtaining therefrom low boiling point hydrocarbons from high boiling point hydrocarbons, and if we will look at the figure 1, down at the bottom left is the cracking unit labeled "cracker," and the coil of that cracker is labeled No. 2. Above it is a vaporizing section or preheater section—
3608 1813 I am sorry—No. 6. Now the oil is fed to that preheater and thence to the cracker from the small tank at the bottom central part of the drawing numbered 18.

Biddison and Boyd teach generally in this patent three different processes. In the first two they circulate oil from the tank 8 in figure 1, just under the label "Fig. 1", down to the pump and through the coils, around and around, so they are circulating through the cracking coils some of the stock that has already been once through, containing its residuum, and those first two operations would be dirty circulation, as we have used it in this case.

He describes also a third alternative process in

which no residuum is circulated and shows a method for withdrawing the residuum that would then accumulate in this tank 8 and distilling it in a tar still, discharging from the tar still a concentrated heavier residuum and preparing as an overhead distillate
3609 from the tar still the vapors, which he condenses as a recycle and thereby keeps the product circulating through his cracking coils clean.

A certified copy of the drawings of this Biddison and Boyd patent as originally filed, is DX 802-A.

3609 1814 I now refer to a simplified drawing (DX 803) which I have had prepared under my direction.

3610 This drawing was prepared with a flap and with the flap down in place it will be used to describe the third method of operation which Biddison and Boyd explained, in which there was clean circulation, and with the flap up it shows the entire arrangement which may be used, and Biddison and Boyd teach its use, for the recirculation of the residuum as well as with clean materials through the cracking coils.

3611 Let us consider it first with the flap up and take up the first two methods, in a general way. The oil to be fed to the process is in the oil tank marked 18 and is continually supplied to that small tank through the line 40 from a larger source not shown. The oil is withdrawn from tank 18 through the line leading from the bottom to pump 22 and is forced through the preheater coils numbered 6 and then through the cracking coils numbered 2.

Please note that just below these coils 2 is another shorter coil 1, and through this coil and from a source not shown Biddison and Boyd teach the introduction into the preheated stream of oil of a gas similar to the permanent gas produced in a cracking still, or they might use natural gas, or things of that
3611 1815 sort. That gas, after being heated in coil 1 is mixed with the preheated oils at the entrance of the cracking coil 2, so that the permanent gas proceeds through that coil with the oils and any vapors produced from these oils.

It is their idea that they can heat the oils in the cracker 2 to an extent, at least, with the highly heated
3612 gases which they introduced. They also figure that there might be some kind of a combination between

these gases and some of the oils that were undergoing cracking.

Leaving the cracker 2 they go through a small device labeled 3, which is supposed to catch any solid particles of carbon, possibly tars that may be formed, and then these hot oils mixed with the gases go up the transfer line 7 to the tank marked 8.

This tank marked 8 contains a body of oil which is cold at the start of the operation, since he suggests filling it in part at the start, and then after the very hot gases and oils from the cracking coils have bubbled through it for a while it, of course, would be heated up to nearly the temperature of the transfer line.

There is a pressure gauge shown on that tank. Then the vapors of the cracked products, including, of course, by the partial pressure effect, vapors of some of the heavier materials as well and also the gas which was introduced through the lowest coil 1 in the furnace, and any cracking gases, pass over the
3613 top line of the drawing 24A. The vapors go up from the top of tank 8 and over to the hot condenser 25.

3613 1816 This hot condenser is shown diagrammatically as a coil. Its function is, obviously, that of a dephlegmator, to knock out or condense the fractions boiling higher than the desired product, and those condensed fractions together still with the vapors of gasoline and the uncondensed gases are separated in the small separator 26.

The uncondensed vapors, including the desired product, go through 28 to the final condenser 29 and are collected in a suitable receiver.

3614 The higher boiling fractions condensed in this partial condenser 25 after separation at 26 flow through the valve 41 back to the intermediate supply tank 18.

Now, from the bottom of tank 8, which started out with coil oil but shortly, of course, come up to nearly the temperature of the transfer line, a body of oil is therein maintained at a cracking temperature and cracking will proceed in that body of oil, the vapors of the lighter products going upward to the hot condensers, as I have suggested, and the residuum will accumulate in this tank 8, which is normally withdrawn through valve 9.

This valve is obviously to be cracked so as to maintain a level of oil in this tank 8 and runs down directly through line 10, valve 20, line 19, and up again to this intermediate storage tank 18, which is the source from which the pump takes its oil to force through the cracking coils.

Therefore it is obvious that into this tank 18, the intermediate supply for the main pump of the proc-
3615 ess, are flowing three streams of oil, the fresh
3615 1817 feed through line 40, the clean condensate or reflux produced in the hot condenser 25, as well as the residuum containing material that was withdrawn from the bottom of tank 8 and which flowed through line 19 either up to that tank or directly down to the pump.

3674 Actually the residuum enters the line between tank 18 and the main pump.

3615 This would be unclean circulation.

This is the first process of three taught by Biddison and Boyd.

Now, please let us consider the tar still and its condensers in the middle of this drawing. He suggests that this residuum is going to build up in the materials being circulated and he doesn't want it to go beyond a certain safe point, and he teaches that, either continuously or intermittently, a certain part of the residuum to be withdrawn from tank 8 is introduced into the tar still, which is fired independently, and it is his purpose to distill this residuum containing material in the tar still so as to produce therefrom, as Burton did, a clean overhead distillate which can be used again in the process.

3616 Now, there seems to me to be an error right at this point in the drawing—I don't mean as this exhibit has been made but I mean in the drawing of the patent as well—in that the valve 42, just before the tar still, seems to be at the wrong side of the upright vertical pipe leading away from the pipe in which 42 is situated, for this reason: He uses this tar still with heat under it to produce vapors which go up to the condenser 12, which again is a hot condenser or dephlegmator, because he is afraid that he might
3616 1818 have entrained some tarry materials from the heavy or relatively heavy residue that he is distilling in this tar still, and he proposes to con-

dence these heaviest materials out, which might contain residuum, separate them from the uncondensed vapors in 13, and lead them back to the tar still to be redistilled. But with the valve 42 placed where it is those vapors, these heavier ones, which he states may contain a certain amount of the residue, would not get back to the tar still at all. They would get back to the line that would carry them directly to the tank 18. They would flow down this line and go back to tank 18.

3617 Now, if I were going to carry out exactly what Biddison and Boyd taught I would put that valve on the other side. You could run it on this side but you can empty your tar still that much faster and you wouldn't have your ultra-clean step of refluxing out this small amount of entrainment which he fears he might get.

I would like to say this, that with the valve on the other side of that upright the operation would be just as well and just as easily operated in the last or third operation which Biddison and Boyd teach. In fact in that operation it would be entirely operable with the valve 42 on either side of that upright line.

Now I would like to call a little further attention to the tar still because what I say about it here will be good later as well.

He shows the tar still heated and he also shows baffles within the tar still, although in his specifications he does not mention either the method of
3617 1819 heating or these baffles. It would seem that these baffles were to be used to increase the length of travel of this material through the tar still
3618 as it is being distilled. That is, at the left-hand side of the still he is allowing to enter from tank 8 a residuum that is not too heavy, and as it flows along through the still, I would say back and forth, behind, and past these baffles, it loses its lighter constituents as a vapor and a heavier residuum is therefore apparently to be withdrawn from the valve and goose neck shown at the right end of the tar still.

He speaks in his specifications about using the tar still continuously. That almost says you must withdraw the residuum either continuously or intermittently, and it certainly would not permit him to use this tar still as Burton used his second still in his

second invention to reduce that residue withdrawn from tank 8 down to a coke. Of course if he wanted to make a coke out of it he would have to have several such tar stills and clean one while he was using the other.

I am further confirmed in my belief that he used the baffles in the tar still to elongate the passage so as to prevent mixing up the lighter residuum fed to
3619 the left-hand side of the still with the heavier residuum withdrawn from the right-hand side, because he shows his furnace continued over only part way under the still. The last one and one-half sections into which the baffles divide the still are not, according to this drawing, which follows that of the patent, to be directly heated.

3619 1820 In this operation that I have just described there is pressure maintained on the apparatus and it is maintained all the way through the equipment over to the final condenser at valve 34, where the mixture of gas, that produced by cracking and that introduced through the coil 1 at the bottom of the heating zone, will be relieved.

Now, in the drawings of this patent following the tank 31, in which the gasoline is collected—there is a device 35, a scrubber, and a line leading to that.

3620 The gas leaving the tank 31, in which the gasoline is collected—the gas of course would separate and be above the gasoline—would contain in that gas a certain amount of light ends of the gasoline which are, of course, of real value, and which it is the custom in refineries to scrub out by passing those gases up through a tank of some kind and contacting them with oil which dissolves the desired fractions, and then at some other place they would be distilled out so that light gasoline could be added to the total gasoline. But we didn't show that in the simplified drawing.

At the bottom of page 1, line 108, the patentees teach as to the status of the hydrocarbons in the cracking coil 2:

"In our process only a portion of the oil in the cracking zone is in the vapor state. These vapors from the oil are mixed with the superheated gas that has been admitted into the cracking zone."

I would assume that that meant that there was

3621 both liquid and cracked vapors in the cracking
3621 1821 coil mixed with the other gas that was added through the coil A.

Also on page 3, line 63, I will read:

"At point C outside the pressure still D superheated gas enters from gas superheater A. The superheated gas plus oil mixture, after passing through pressure still D"—

This pressure still D is the cracking coil. That is just a little bit—at least it is not quite so obvious. He says, "The superheated gas plus oil mixture". You would have to read into that "superheated gas" some of the vapors that might have been produced by heating the oil itself, in order to make it jibe with the statement at the bottom of page 1, line 108, but I should think from those statements that he proposed to heat and crack his oils in the cracking coil D and obtain some vaporization from the oil as well as to have present, of course, the gases which he adds.

In the last quotation that I have read I referred to pressure still D. That is the reference character
3622 given to the character in figure 2. That is the cracking coil. In Figure 1 that same cracker has the reference numeral No. 2.

The discussion I have just given of the first operation of the Biddison and Boyd patent was to deal with a definite quantity of oil. He partially filled his tank 8 and his tank 18 and apparently ran for a while cleaning some of the residue up in his tar still, and then stopped and apparently began all over again,
3622 1822 because he makes the point that his second operation is just like the one I have described except that during the course of his second operation he continues to feed in fresh oil from the line 40, so as to maintain a supply in the system. Of course that would be the more economical and reasonable thing to do, to just run for a longer time instead of stopping because he happened to get to the end of the oil that he had chosen to start with.

3623 The apparatus carrying the reference numeral 3 is a device in which they expect to collect and eventually blow out through the valve 4 any carbon or carbonaceous or tarry residues which they may collect in it. That might have some importance. It might be useful even in the first two operations where they

are circulating through these coils the residuum which has been forming in tank 8, and they might succeed in getting rid of some of it at that point. They would doubtless lose with any such tar or tarry residues some of the good values left in the oil. However, I am sure that in the third operation where no such residues are circulating there would be no such carbonaceous particles or tarry residues to be accumulated in 3, and I assume that that was not to be used in the third operation. Its presence there would do no harm but I don't see of what use it would be.

For the third operation we will turn the flap down, and you will note that the line which formerly connected the bottom of tank 8 back to the line between the intermediate supply tank 18 and the main pump is omitted from the drawing particularly in-
3624 1823 terested in does not teach the return of any part of the residuum from this tank 8 back to the line between the intermediate supply tank 18 and the pump and the coils.

This third operation is operable with the valve 42 located as Biddison and Boyd show it.

It doesn't matter whether valve 42 is where it is shown on this drawing, the same as it is in the patent, or whether it is on the other side. As a matter of fact it could be entirely omitted and let the valve 9 control the rate at which the residue, the light residue in the tank 8 is admitted to the tar still for the cleaning up process.

Describing the third operation, the tank 18 again is an intermediate supply tank which is fed either continuously or intermittently through line 40 from a larger source not shown.

From this tank 18 the pump 22 at the bottom of the page again pumps this charge through the preheat-
3625 ing and cracking coils. The highly heated non-condensable gas is also mixed in the same way. It goes through the carbon catcher, if you will, No. 3, which won't have any function to perform in this operation, and then up through the line 7 and again to this tank 8 shown partially filled with oil.

Biddison and Boyd are not specific as to just how much oil should be in that tank. They teach starting up the apparatus by putting some in.

In Figure No. 1 of the patent there was no oil level

shown in the tank and the line 7 is not shown down beyond the top of the tank. In this figure 1 there is no oil shown in the tank. This figure 7, I mean this pipe line 7, doesn't show beyond the top piece of steel of that tank. In Figure 2, however, your
3625 1824 tank is shown about half full and the line 7 bringing the vapors and oils from the cracking coil is shown bubbling through that mixture. I am sure that the latter is the way that the process would be handled because there would be no adequate means
3626 of heating the oil in the tank 8 if the hot gases and oils from the cracking coils didn't bubble down through.

The tank 8, partially filled with oil, will of course shortly be raised in temperature to somewhere near that of the transfer line, and this body of oil in 8 will be maintained at cracking temperature for a period, thereby getting a time factor for adequate cracking.

The vapors again will leave the top of this tank, consisting of the desired product, gasoline, the recycle that will be vaporized at those temperatures and pressures, and with the gasoline acting as an assistance because of the partial pressure effect and together with the gases from the two sources again going over the hot condenser 25, acting as a dephlegmator, again knocking out the heavier fractions to form a clean recycle in 26, the uncondensed vapors, of course, again passing over the final condenser 29 into
3627 storage. The condensed recycle separating in 26 would flow down through the valve 41 into the intermediate supply tank.

Now, from the bottom of the tank 8, which of course as soon as it gets up to cracking temperature becomes a reaction chamber, is withdrawn a residue through valve 9, which may be cracked or opened wide
3627 1825 intermittently. He teaches either. This oil withdrawn, a residue—I mean a heavy oil in which a residuum content has built up—is again fed either continuously or intermittently to this tar still which is heated until vapors are driven off and the residuum in the heavy oil entering the still is concentrated. Certainly a heavier residuum is discarded from the tar still through valve 21 than was allowed to enter the tar still. The vapors that were created in the tar still would consist of a recycle stock, a heavy

product, which again he puts through a hot condenser labeled 12 and which acts to dephlegmate out and knock back any very heavy materials which he fears again might contain residuum.

Those are separated in 15 and run back to the tar
3628 still for further treatment. The vapors from 13, the uncondensed material leaving the hot condenser 12, are finally condensed in 17 and they also flow back to the intermediate oil tank 18.

Now, this intermediate oil tank—there is one thing I would like to go back on. I don't think I made a point of this. In this operation of the tar still, the operation which he is carrying out is for the same purpose as that of Burton in his second patent, to produce from the residue withdrawn a clean overhead distillate. Certainly he would operate that as Burton did; I mean to the extent of operating that tar still at atmospheric pressure instead of any super-atmos-
4 pheric pressure which would be maintained on
3628 1826 the cracking coils and on the bulk of oil in the reaction chamber 8. There would be no point in taking materials out of 8 in the form of a light residuum and charging that to a tar still if that tar still were to be heated directly to produce vapors, because of course under pressure the tar still then would become a cracking still and he would be in
3629 trouble right away. He would be doing just the thing that Burton found and taught must not be done.

That would mean that in operating this device as shown on this drawing with the flap down the valve 9 at the bottom of the tank 8 would be cracked so as to maintain a body of oil in 8, and under pressure, and that would permit the oil to flow through 9 in a small stream, or intermittently in large streams, as desired, to this zone of lower pressure.

Now the same reasoning must hold with respect to valve 41 below the separator 26 and hot condenser 25. Above that valve is the full pressure of the system which is maintained all through the condenser and the receiver and the final relief valve for the gas line 34. That valve 41 would therefore be operated in such a manner as to maintain a pressure above it and to permit the recycle as fast as it was condensed to go down into intermediate oil tank 18.

In case there would be a point as to whether or not

in the tar still the operator will actually operate it under atmospheric pressure or at the full pressure of
3630 the whole cracking system, I know of no way of using this intermediate oil tank 18 unless, of course, it is fitted with the proper vents and gauges so that
3630 1827 the operator will know what he has got in it.

He is going to be removing from that tank 18 a continuous stream of oil for his process. He is going to be feeding to this tank 18 oil from three sources, after the apparatus is in equilibrium, a fairly definite and regular amount of recycle from the hot condenser 25 and separator 26, through the partially closed valve 41, and also a regular amount, or an amount which is large and small by turn as he feeds the tar still intermittently or continuously following the tar still operation, and then the job of the operator would be to so regulate the valve shown in line 40 that the fresh oil fed to tank 18 would maintain a level somewhere between being empty and overflowing.

On the drawing of figure 1 of the patent there is
3631 shown a heat exchanger 16, which is not shown on the simplified drawing (DX 803) for the simple reason that it just complicates it and has nothing to do with the process itself. The vapors that are produced in the tar still and which must be condensed require some cooling device. It would be economical to use as part of the cooling liquid the cold oil which is to be heated up in the process and later cracked. That heat exchanger is for that purpose. It was omitted, as I say, for simplicity's sake on the simplified drawing.

Q. Now will you refer to the patent and just indicate where these three systems of operations are taught?

A. Page 2, line 107:

3631 1828 "Thus three systems of operation are available."

The first system is the batch unclean circulation system where residuum is circulated, and that is described between lines 109 and 123, and then at 124 he says:

"Or, the same system as above may be followed except that the oil level in tank 8 is maintained at practically a constant level."

3632 That is his second system, also with unclean cir-

culation, but it will run for a longer time because he continues to add oil.

Then at the top of page 3, at line 4, he describes his third system, and I will read that paragraph:

"Or a system of operation may be followed where the oil level in tank 8 is maintained at practically a constant level by means of either continuous or intermittent admission of oil through line 40 and the still 11"—

that is the tar still—

"is used continuously for the removal of tarry matter and carbon by passing the oil from tank 8 through valve 42 into still 11",

and so on through the other pieces of apparatus as I have described.

As to the character of the vapors that are taken from the tar still and fed to the tank 18, I will read from line 95, page 2:

"From 11"—

3633 that is the tar still—

3633 1829 "the distillate vapors pass by 15 to hot condenser 12 where any tarry matter carried mechanically by the vapors is knocked out into 13 and which tarry matter passes back to still 11 by line 14. The clean oil vapors"

and so forth, pass on.

That just indicates Biddison and Boyd's intention of getting an entirely clean product in the vapors in that tar still. That is almost ultra-clean circulation.

The patent, page 1, beginning line 35, refers to the difficulty of maintaining a constant rate of distillation, "fifth, the difficulty of removing carbon continuously from the system," and then I will read from line 41:

"The object of our process is to provide a method whereby these difficulties are reduced to a minimum in the distillation of petroleum residue for the production of low-boiling-point hydrocarbons. This is secured in our process by, first, the fact that excessive

3634 heat is not required on the walls of the still which is attained by keeping the temperature of the superheated gas high enough so that it, in connection with the lower heat on the oil-container walls, causes most of the decomposition."

In other words, one of his objects is to heat that oil without the possibility of overheating in the coil,

and he directs part of his invention and one of the objects to that method of heating.

The second object is described in line 53:

"Second, the maintenance of a steady temperature control by regulation of the flow of gas through the superheater; third, the maintenance of very constant pressure by a regulating pressure valve on the gas inlet or outlet."

3634 1830 That means pressure throughout the cracking, dephlegmating and condensing zone, and he apparently is going to maintain that constant in this case, of course, not only by withdrawing the uncondensed gas at the end of the final condenser, so as to 3635 regulate it, but since he is forcing gas in at the first part of his system he has to take that into consideration too. He has to take care of the gas at both the inlet and the outlet.

His fourth object, continuing my reading:

"Fourth, the continuous removal of carbon by distillation from the cracked oil by means of intermediate stills—"

I was particularly interested in the plural since if he chose to take the residue in the tar still down to coke he could use the stills and be cleaning one while using the other.

"—intermediate stills so arranged that they can be used intermittently for removal of carbon and tar when it accumulates in quantity or can be used for the continuous removal of same, fifth, the maintenance of a steady rate of distillation by the gas flow."

Now, on this drawing (DX 803), I have shown a 3636 number of dot and dash vertical lines. That was merely a convenient means of dividing the process into sections. That part of the apparatus shown at the left of the first line is the heating and cracking zone. That between the first line at the left and the next one shows the zone in which the vapors are separated from the residual oils in tank 8 and where the fireless cooker principle is carried out.

3637 1831 In between the second dotted line and the third are shown the tar still and its dephlegmating and condensing devices. In between the fourth line and the fifth are shown the dephlegmating devices and the intermediate storage tank, and at the

right of the fifth line is the final condenser and storage for the product.

Q. Will you now please summarize the principal operating steps taught by Biddison and Boyd in their third operation in which they continuously use the tar still 11 which you have described?

A. They teach the forcing continuously of a charging oil through preheating and cracking coils, mixing with some very hot gases and carrying the oils and vapors over to a reaction chamber 8 where further cracking takes place; removing vapors from that reaction chamber 8 to a dephlegmator from which is condensed a clean reflux, and separating the vapors of the desired product at that point and carrying them to a final condenser and receiver.

The reflux from the dephlegmator is mixed with the oil to be shortly fed to the cracking furnace so that its heat is conserved.

3638 From the bottom of the reaction chamber the residuum is withdrawn continuously or intermittently and by means of a tar still and suitable condenser a further quantity of clean recycle is obtained by
3638 1832 distillatory process which is added to the charge going to the cracking still, the final residuum from the tar still, of course, being discarded.

I now refer to the Ellis patent 1,396,999 (DX 804), filed October 4, 1913, and issued November 15, 1921.

The feed for the process, a distillate, is forced into the cracking coils at the point marked 5 on the Figure 3. There is a side connection at that point, 5^1, which is for steam.

3639 Ellis teaches the forcing of these oils through the vaporizing and cracking coils together with a certain amount of steam.

Note that the line from 5 continues horizontal across the furnace and is not clearly shown but it is obvious that there are four streams taken from that one line, and the zigzag arrangement in that furnace just under that pipe line indicate four individual cracking coils, each with several passes back and across the furnace, and they each end in one of the four vertical lines with a curve at the bottom of them, labeled 6 in the drawing; and go up to another header labeled 7. Thus

the small cracking tubes in this Ellis patent are shown as four parallel courses, each with several tubes.

That method of heating in the four parallel tubes produces the need of less head on the oil to be forced through because you have four paths, but it offers engineering difficulties and operating difficulties like most of us that have dealt with cracking operations shy away from. If the tubes in one section, for
3640 1833 example, for any reason receive less than their equal quantity of oil they will become overheated and may coke up. Or should the furnace be designed so that the tubes of one of these coils was much more strongly heated than the others, regardless of the amount of oil, it might be the one that cokes up. It is rather easier to make a single longer and continuous coil than to have four coils in parallel. However, such an arrangement could be operated, the engineering and operating difficulties would be greater and would have to be overcome.

The combined effluent from those four coils, after they are combined in the pipe line 7, the horizontal one, enter the large circle just above, which he calls a digester and which run for some distance back to the furnace, probably the length of a piece of pipe of those days, 20 feet or something like that. This is much larger in diameter and it is maintained at about the temperature of the vapors after they leave the coils. He has got that shown in the furnace, and he teaches holding the temperatures somewhere near
3641 that point. That digester is No. 8. It is obviously there for the purpose of obtaining the additional time factor at the cracking temperature which he chose to employ.

All of the oils fed to the four parallel cracking banks are vaporized and the cracking occurs largely in the vapor state, and the digester 8 would receive these vapors, practically all of the oil now in the vapor state, through the line 7 and at the far end
3641 1834 would emerge still as vapors through the line 9 and be carried to the combined vapor separator and fractionating device marked 10, this tall column.

In his patent on page 1 at the bottom, line 103 he describes this fractionating column:

"From the digester the vapors may go to a dephlegmator or fractionating column which prefer-

ably is of a type used in the rectification of alcohol and the like in place of the ordinary coarse dephlegmator used in the present day rectification of oil."

Now that indicates that he had in mind using a fractionating column in the top part of which, perhaps in the top half of which he would doubtless have
3642 bubble trays and caps to do an excellent job of fractionating.

At the lower part of the tower, and I am thinking of the alcohol stills where the thin mash containing the grain from the fermenters is pumped directly into the lower half of the column and then steam blown up through, there are never bubble caps in the lower part. There are plates, of course, with holes in them, about as many holes at they can put in them, about an inch and a quarter or sometimes 1¾ or 2 inches in diameter. I should think that since he refers so specifically to that type of fractionator, he meant the lower half to be a coarse fractionator and the top half the bubble cap type.

The vapors entering the bottom would pass up through the dephlegmator. Cooling is provided at the top so as to produce dephlegmation and everything would be condensed in that tower except his desired product which would be taken off over-
3642 1835 head as gasoline vapors and could be thus immediately condensed.

3643 However, Ellis is concerned with a special treatment involving desulphurization and hydrogenation, and so forth, to produce a very special kind of motor fuel. Those last steps need not concern us here. It will be much simpler if we assume that the desired product taken off is a vapor from the top of the fractionator that is merely condensed and put in a suitable receiver.

This fractionating tower, since three pet cocks or valves are shown at the right-hand side of it, labeled respectively 11, 11-A and 11-B, indicates that side streams are to be removed from this tower. That means that at each of those points there would, of course, have to be a tray on which oil at that level in the dephlegmator would accumulate so it would run off and the upper one probably would have bubble caps on the trays, but I would think probably not the lower ones.

From the lowest point in the tower the side stream from 11 would correspond to the heavy residuum produced in the cracking and condensing in the dephlegmator 10.

From the second up side stream 11-A, Ellis describes a gas oil fraction, a heavy gas oil fraction
3644 which probably would be clean but he indicates that it is heavier than he would choose to use as a feed for his particular process.

3644 1836 From the upper side stream taken off at 11-B, Ellis states that a fraction like a heavy kerosene would be withdrawn particularly if kerosene is the charging stock which he originally used. And he teaches that that stream, the kerosene side stream or recycle is a suitable stock for returning to his cracking coils.

The specification teaches that, at page 2, line 2:

"In the dephlegmator or fractionating column the heavy oil is condensed and if desired a dephlegmator may be arranged to yield as fractions a gas oil and unconverted kerosene especially if the latter is employed as the raw material. Preferably, however, the kerosene is separated from the heavier oils and the former returned to the decomposing tubes while the latter which is preferably separated as a fraction similar to gas oil, is collected and suitable disposition made thereof."

3645 Ellis teaches dephlegmating his vapors in this fractionating tower so as to get a kerosene to return to his cracking coil because he is dealing with a high temperature vapor phase cracking operation and he would have a little happier time with a light stock than with a heavy stock, and certainly he would have to have a clean stock in order to use it in such a process.

Also I think we ought to consider a bit the times. This was 1913 when Ellis filed this application, and it just happens that part of that time at least kerosene was almost a waste product. The gas oil was in demand because Burton was teaching how to
3645 1837 crack it. Burton, of course, would have to deal with very high pressures if he had attempted to crack kerosene. So these vapor phase processes at that time were frequently aimed at the use of kero-

sene as preferred charging stock because it was more available to them.

3646 There is no mention in the patent as to how the side stream of the unconverted kerosene, as he calls it, is to be returned to the cracking tubes. He has shown the fractionator at a fairly high level in his diagrammatic drawing, and it is conceivable that at that level the hydrostatic head from that point in the dephlegmator tubes to the entrance of the cracking tubes could be made such that it would flow back without any pump, although he would have a better process if he had been able to find a pump that would handle that hot product and pump it back through it.

Mr. Hall: Your Honor, may I suggest that the witness should not—I would like to ask that the previous answer be struck out. When this witness undertakes to say what Ellis probably had in mind or probably did not have in mind when he hasn't the slightest foundation in this patent,—it is all right to explain this patent to your Honor and what it shows—

The Court: Yes.

Mr. Hall: But to set forth what Ellis probably had in mind, that he probably thought of a hydro-

3647 static head and he was going to use a hydrostatic head to return this material, of course, he hasn't any foundation whatsoever for any such statement. I doubt if he ever knew Ellis or worked on an

3647 1838 apparatus of this kind, or has anything of that kind, or any foundation for it whatsoever.

Mr. Thiess: Well, the witness has stated that Ellis shows or teaches that this kerosene should be returned to the coil.

Mr. Hall: Sure, he could take it in buckets.

Mr. Thiess: He refers to the drawing and from the drawing he says that very likely this could be done.

The Court: Yes, but I don't think he may testify as to what Ellis probably had in mind. That, of course, is going way beyond any competent testimony. It would not mean anything if it was in the record, just to read it.

Mr. Thiess: Let me ask—

The Court: Probably having such a thing in mind would not be evidence of it.

Mr. Hall: That, your Honor, it seems to me, is the province of the lawyer to argue those things to your Honor.

3648 The Court: I say, I am sustaining your objection.

Using the four parallel coils in the cracking zone as Ellis has shown would, of course, considerably cut down the resistance over that which would have to be overcome if all of those coils were in one continuous length of tubing, so less pumping or a less hydrostatic head would, of course, force it through.

3649 Ellis teaches, with respect to pressure, that "The apparatus is preferably run"—I am reading page 4, line 8:

"The apparatus is preferably run at a slight pressure although a considerable pressure, as several atmospheres may be employed if desired."

3649 1839 He is not very specific about it but he indicates that some kind of pressure is to be used.

Q. Will you now please summarize the operating steps as taught by Ellis?

A. Ellis teaches charging a clean distillate stock to cracking tubes where the stock is practically com-
3650 pletely vaporized and cracked; carrying it through a tube of larger diameter, called a digester, in order to obtain the time factor; and then through a good fractionating device, condensing out the heavier portions so as to produce overhead as vapors from that fractionating device only his desired product, and he further uses the fractionating device to separate these heavier portions into three different qualities of oil. One of which is a clean light stock, which he says is kerosene or the like and which he suggests may be used by being returned to his cracking coils. The heaviest of these three stocks would contain his residuum, and the intermediate one would be, as he describes it, a heavy gas oil.

I feel that the cracking and the fractionation steps taught in the patent are entirely operable. I don't know enough about the hydrogenation and desulphurization steps he discusses at the end of his treatment to have any opinion on that.

3651 Q. Have you had any experience with a vapor phase process of this type which would substantiate the operability of the process which you have just explained?

3652 A. In a few words I would like then to describe the operation that was conducted in the yards of
3652 1840 the Arthur D. Little laboratory in '24 and early '25 and which was carried to Tiverton, Rhode Island, the next year and operated on a larger scale there.

It was a vapor phase process. Gas oil was the charging stock. The oil was vaporized and much of the cracking done in small tubes, perhaps an inch in diameter—in the case of the Tiverton 250 barrels a day unit. The transfer temperature at that point was just under 1100 degrees Fahrenheit, and from that tubular heater with a single pass, a single chain of tubes—not with four banks as Ellis shows,—from that tubular heater the effluent vapors entered a digester almost exactly like the Ellis digester. It was
3653 a 12-inch diameter tube; it was 30 feet long, the first 20 feet of it, as I recall, were within the setting of the furnace, and I am sure there was no very great amount of heating done but the temperature did not drop in those tubes because we had pyrometers all along there and the gas temperatures were just around 1100 degrees Fahrenheit. And when I stated that I thought the Ellis operation as disclosed here would function in an operable manner, I had in mind particularly that digester in Tiverton, which operated week in and week out and which, to the best of my knowledge, was only cleaned in a perfunctory
3674 manner about twice in the year that the thing operated. I do not want to create the impression that it ran continuously forever and forever. Actually that plant was run during the week and shut down week ends. The longest run that I recall on that plant was
3653 something like 27 days but most of them were a week or less. We had no carbon trouble in that digester which was very much like this large tube which Ellis shows and labels "digester".

3653 1841 That plant operated at Tiverton for a little
3654 more than a year overall and there were several months during that period when it did not operate. It operated actually less than a year.

Mr. Hall: Q. Never went into a commercial still, did it, a commercial refinery?

A. No, Mr. Hall. I think we will both be happier if I tell you that that whole development was not

aimed at the development of a new cracking process. We were using those gases to make higher alcohols. The cracking was an incident. We had to have a cracking plant to get the gas and we just had to make gasoline which we sold as a by-product. It just happened to be something of this type and it does give me a background from which to state that I am certain that this digester of Ellis would not give him trouble, as I have seen such a thing operate for such a period.

3655 I now refer to the Trumble patent No. 1,281,884 (DX 527), filed July 19th, 1915, and issued October 15, 1918, and to a simplified diagram that I have had prepared (DX 805).

3656 The feed tank and pump are shown at the lower left-hand part of the drawing. And this oil which Trumble teaches may be a crude oil or a topped crude or distillate or almost anything is pumped through the tubular heater under a pressure which is maintained by valve 22, the pressure control valve shown at the end of the heating coil.

Trumble teaches that the heating and the cracking in this coil is such that a foamy mixture is produced; that is, considerable vaporization occurs in the

3656 1842 coil and a foam is produced within this coil and at the pressure control valve the pressure is released permitting, of course, further vaporization, and the unvaporized oil and these vapors enter into what he calls a vapor releaser, shown as Figure 2 on the drawing, and that acts as a separating chamber for the unvaporized portion of these oils and the vapors formed. The uncondensed portion, that is the

3657 vapors pass over to the two dephlegmators shown as 47, where the heavier portions are condensed forming a clean recycle which is drawn off the bottom, and the uncondensed vapors, the desired products, pass on to the final condenser as usual.

Now, coming back to the vapor releaser No. 2, the heavy unvaporized portions of the oil which would, of course, contain not only any residuum produced during cracking but the heavy residual materials that would have been present in most crudes and including some dirt, sand, and things which Trumble mentions, might also be present and all descend down

the conical bottom of the vapor releaser 2 into the smaller tank with the conical bottom No. 3, called the settling tank.

Now you will note that the clean reflux condensed out in the dephlegmator 47 is also going down and goes into this same settling tank where it, of course, is mixed with the heavy residuum withdrawn from the vapor releaser.

3658 And also note, please, that a circulating pump picks up this mixture of clean recycle together with the dirty residuum that comes down from the vapor releaser and pumps that whole thing together with fresh feed around and around through the cracking coils.

3658 1843 Now Trumble speaks of that process as a cyclic or ring process, and this ring consists of the cracking coils, the vapor releaser, the settling tank and the pump and pipes, bringing it back to the tubular heater.

He teaches sending this oil around and around, cracking it a little each time and increasing the amount of residuum in it, but he teaches that if this residuum accumulates to a degree or to more than a certain degree he will find himself in trouble, so he shows a residuum drawoff at the bottom of the tank, settling tank 3, from which he withdraws residue continuously.

He states also that he feeds fresh oil to the process from the feed tank 7 continuously; and that he balances up the amount of feed in so it will be equal to
3659 the amount of product taken out as a final product from the final condenser, and the amount of residue withdrawn off.

He teaches maintaining not only the volume of oil constant in his ring system, but also teaches maintaining the amount of residue that he circulates, constant. I do not know as they add very much to the clarity of the picture, but in Figures 8 and 9 Trumble shows the ring and shows the point where the feed is put in and where the product is taken off.

Trumble starts with an oil which is not necessarily clean; I can read into his description that he might use a distillate but he teaches the use of a crude oil or one which has been processed somewhat which

probably would be a reduced crude and teaches
3659 1844 possibly in that crude there would be some dirt
3660 so he starts, we will say with a fairly dirty material and as he cracks he will produce some of this residual type of material which we have been discussing in these other patents which, of course, would increase the amount of dirtiness that he circulates, and he states that he should withdraw from his settling tank 3 this residuum at a rate to maintain constant the quality of the stock being circulated.

As to what percentages of the residue Trumble teaches to withdraw from his ring, he may be a little optimistic on that. He says on page 2 at line 42:

"In practice as very small flow of heavy oil through the release pipe is sufficient to prevent undue accumulations of objectionable solids in the body of the circulating oil. For example with California oils on which the apparatus has been commercially operated the amount of oil withdrawn through the release pipe is less than 5 per cent of the oil introduced through the makeup pump."

3661 The advantage in recirculating this residue is, of course, he will crack it further each time he recirculates it and will produce thereby an additional amount of his desired product. Whereas, if he withdrew from this settling tank 3 a very large quantity of residue, he would withdraw at the same time some of the clean recycle he had produced in his dephlegmator and would be throwing away good values with his residuum. So he apparently strove to keep the per cent that he withdrew to the minimum and mentions only this 5 per cent of residue. I cannot believe that he could be cracking very deeply and making a large amount of gasoline per pass and then be able to
3661 1845 maintain constant, as he teaches, the amount of residuum which he circulates if he withdraws only five per cent.

In the withdrawal of this residue, he would be withdrawing some of the material that might be used as a charge that would be his problem. Every time he
3662 withdrew some residue he is going to withdraw also at the same time some good reflux because, although he calls it a settling tank, I do not think any of us feel that the residuum would just go plumb down to the bottom and not mix at all with the lighter con-

densed reflux. There might be some differential settling but I would not press that point. He is going to be pulling out good reflux at the same time he pulls out residuum from that tank.

Q. Now, with residuum that Trumble withdraws, to some man skilled in the art, would it be advantageous to treat that the same as Trumble taught to get some good charging stock?

A. You mean that Burton taught?

Q. Burton, pardon me.

A. Yes, if he withdraws—

Mr. Hall: Well, your Honor, how is this at all pertinent in this case, what a man skilled in the art would do with the residue from Trumble?

The Court: I don't see.

Mr. Hall: Trumble makes no teaching at all about it.

The Court: I do not see how it is pertinent.

Mr. Thiess: Well, he has residue here—

The Court: Yes, if he does, what bearing does it have on this case, what might be done?

3662 1846 Mr. Thiess: It is not a question of what might be done. The residuum that is withdrawn contains some of the clean charging stock.

The Court: Yes.

Mr. Thiess: Now that could be treated to get a clean charging stock for the system. He could do that with all of the residue or part of the residue.

The Court: He does not teach that in his patent.

Mr. Thiess: No, he does not. I asked him whether a man—

Mr. Von Holst: Well, if it was within the skill of the art at the time this patent was taken out, an expert certainly is entitled to tell, to testify what one skilled in the art could do.

Mr. Thiess: And the Burton patent was issued prior to the Trumble patent and the teaching was available to a man skilled in the art.

Mr. Von Holst: It is a question of the teaching of the patent in the light of the then existing knowledge as well as what actually is taught in the patent.

The Court: Well, you don't convince me but I will let it go in. I may be convinced.

Mr. Hall: I submit, your Honor, that is just a matter of argument.

3664 I think with Burton's teaching before him, an operator who was withdrawing a large quantity of residue from this settling tank 3 might well have fol-
3665 lowed Burton's teaching and produced a clean stock which he could have added to the feed in this process.

Trumble has a lot to say about velocity. On
3665 1847 page 1, line 72, way down at the bottom of the page and over on the next, he says a number of things. I will read a bit of it.

"the oil contained in the closed ring described above is forced through the heating means at a high velocity. The heating means comprises a series of pipes suitably connected to form a single continuous heating coil. The oil enters the coil at a moderate velocity and as it passes through the coil large quantities of vapors are gradually produced therein. This vapor remains intimately mixed with the body of the oil due to its rapid motion forming a foam which gradually increases in volume and consequently travels with an increasing velocity through the heating coil."

3666 1848 In the rest of the same column on page 1, he gives several of the important results resulting from this high velocity. A, he gives "This high velocity results in a high efficiency of heat transference."

And then, B, "This high velocity results in a very uniform heating of the foamy mixture."

And C, "This high velocity prevents the deposition of carbon, or other solid or viscous materials on the interior of the heating coil so that the apparatus cannot become clogged"—

And D, "This high velocity prevents unequal heating" of the oils. I did not read each of those completely, just the first part of each.

In the matter that I have just quoted respect to velocity, I referred to the foam. Trumble refers to this foamy mixture in his coil at other places in his patent. On page 4, line 75:

"As it circulates through the heating coil a portion thereof is broken up to form a lighter hydro-
3667 carbon, the small globules of light vapor being swept on by the moving mass of oil which assumes a foamy nature. This foam greatly increases the volume of the flowing stream which therefore accelerates rapidly."

And just below that, in line 93:

"The foam remains in the heating coil only a very short time."

Also on page 5, line 55:

"Second, the immediate release of the foam so produced the removal of the vapors therefrom and the immediate recirculation and reheating of the oil to form more foam, the oil being kept in continuous motion over a closed ring or path."

3668 1849 And there are other places in the patent that is in.

With respect to pressure, Trumble teaches, page 2, second paragraph, line 7:

"Fourth, the apparatus disclosed herein is especially adapted to work under pressure."

There are several other places where "pressure" is mentioned.

At line 60 at the bottom of the same page:

"In the apparatus described herein the oil circulating in the closed ring is maintained under constant conditions of temperature, pressure, and composition, so that the character of the product obtained remains constant."

On DX 805, this pressure is maintained up in this
3669 pressure control valve 22, all of the cracking being done on the pressure side of the valve in the coils.

Q. Now, will you please summarize the process steps as taught in this Trumble patent?

A. Trumble teaches a continuous cyclic or ring process in which residuum is recirculated. This consists in forcing a stream of heavy oil through a continuous heater where it is heated and cracked with much vaporization, and under pressure; releasing the pressure, separating the vapors from the residue; dephlegmating the vapors to produce an overhead final product which is finally condensed and returning the heavier condensed vapors from the dephlegmator to the inlet side of the system as a clean recycle.

3671 He teaches withdrawing residue from that system so as to keep a balance between the stock charged and the final products withdrawn.

The Court: I don't know whether these summaries are quite fair or not. You have in your brief a statement, very short and concise, and the other

side, if they wish to analyze that, have got to go to considerable trouble to do it to make the quotation, the short quotation from the witness. I now
3675 1850 refer to the Alexander patent No. 1,407,619 (DX 806), filed November the 30th, 1917, and issued February the 21st, 1922.

3677 Alexander describes no less than eight different variations of a cracking process. Each of them, however, is concerned with the production of vapors from a vaporizing unit and the cracking of those vapors while substantially in the vapor state in a tubular cracking device; and then the dephlegmation of those vapors to remove generally a heavy residuum and a clean recycle, and the final condensation of the gasoline he wants to make. But in most of those operations he does not distinguish very well between the residuum condensed in one part of the condenser and the clean recycle in another, and he mixes them together and returns them to the vaporizing unit.

However, in one of his operations, the last one in
3678 Figure 8, he keeps those two condensates separate and returns to the cracking unit only the clean recycle and discharges from the process the residuum. It is that last process that Alexander teaches in Figure 8 that will be most interesting here.

Alexander is very specific with respect to pressure. He wants to operate at approximately atmospheric pressure. He refers to that in more than one place. For example, page 3, line 14:

3678 1851 "For practical purposes, insofar as the type of cracking here interesting is concerned, the influence of pressure is negligible and any degree of pressure greater than atmospheric is undesirable, and particularly any degree which would tend to restrain vaporization of liquid hydrocarbons."

Thus he talks in other places in the patent about having dry vapors in his cracking process and urges that the pressure will prevent the vaporization and he wants his oil vaporized, and therefore teaches the use of atmospheric pressure.

3679 The process disclosed in the Alexander patent in Figure 8 is shown in the simplified drawing of this process (DX 808).

This simplified drawing with the flap has been

prepared so that it would better illustrate the variation which Alexander suggests is permissible. The picture in the drawing of the patent is similar to the simplified drawing with the flap up.

3680 The shell still as shown with a flap turned up, is the vaporizing device in this alternative which Alexander teaches for the process No. 8 in his patent. The feed for the process is crude oil pumped in through the pump 112 at the bottom center of the drawing (DX 808), and is pumped to the top of the first of the tall columns shown, labeled the vapor separator and is apparently to be sprayed into
3680 1852 that column at its top. The hot gases from the cracking tubes enter the bottom of that same
3681 tower through the line marked "transfer line".

That tower is a point where several things occur. The high temperature gases entering the base are quenched, cooled by this cold crude oil that is sprayed into the top and, of course, the crude oil is both heated and vaporized to a considerable degree, so that there remains left as a liquid in this tower the residuum that was present in the gases coming from the cracking zone, together with the residuum that was originally present in the cold crude oil fed to the top of that tower; and that combined residuum is withdrawn through line 114, pump 115, to suitable storage.

The vapors left behind in this column constitute the gasoline that was made in the cracking process, together with any permanent gas, any gasoline that was in the crude oil fed, and the recycle stock from the materials unconverted in the cracking process and, of course, the fresh or virgin gas oil, all of the stock
3682 vaporized from the crude, except the gasoline which went overhead. Those vapors are passed through a fractionating tower, so labeled in this simplified drawing, and cooling so arranged that the desired product gasoline is taken overhead to a final condenser as usual.

From the bottom of this fractionating tower, through line 120, is recovered the entire charge which this particular process of Alexander teaches put-
3682 1853 ting through the vaporizing and cracking tubes, this charge consisting of the clean recycle carried overhead as a vapor from the vapor separator

together with the gas oil produced from the topped crude by distillation in the vapor separator, and in which of course the heat of the cracking gases was employed to distil it. This combined feed, virgin gas oil and recycle, flows in this illustration by gravity back to the shell still and it being a clean stock itself, the distillate, would be readily vaporized by a suitable source of heat under the shell still and these vapors would rise through line 122 and pass through the cracking tubes 113 where the cracking occurred
3683 in the vapor state, the cracked products of course, following back through the transfer line to the bottom of the vapor separator, as I have already suggested.

Now with the flap down there are two changes to be noted in the apparatus diagrammatically shown in this drawing. The shell still has been replaced with a tubular vaporizer which is provided for by Alexander in the specification at the end of his discussion of this Figure No. 8, on page 6, line 95. I will read:

"The vaporizer shown in this view is a still similar to still 109 shown in Figure 7 but under some circumstances I may employ in lieu thereof such a special vaporizer as the element 75 of Figure 5."

This element 75 is a diagrammatic representation of a continuous single path tubular heater similar to the figure in this drawing with the flap down, marked 75.

3683 1854 The other change is the pump marked on this simplified drawing "reflux pump" which Alexander shows in his Figure 5 in connection with his vaporizing tube 75, so I have shown it here as a pump to force the combined feed of reflux and virgin gas
3684 oil back through the vaporizing tubes and the cracking tubes.

There is one other matter on these drawings which is common to either of the two alternatives, that is, with the flap up or the flap down. That is the pump at the lower left, 122-A, "clean feed" I have marked it, going through line 121-A to the vaporizing tubes or to the shell still with the flap up.

Apparently it is necessary, Alexander states that it is necessary at times to force an additional quantity of feed into his vaporizing device.

Mr. Thiess: Q. Dr. Reiman, will you now correlate

this description that you have just given on the diagram Exhibit 806 with the written description in the patent?

3688 A Referring to the patent on page 6, line 42:

"In Figure 8 of the drawings I have shown an apparatus particularly applicable for use in the present process wherein crude oil is stripped by the aid of the cracked vapors, this oil being fed to the exchange tower 110 through pipe 111, by means of pump 112. Heat exchange and evaporation and condensation take place in the exchange tower, certain products such as gasolines, kerosenes, solar oils and gas oils being vaporized by the vapors from the cracking tube 113."

3688 1855 Three functions are accomplished by this heat interchange with the crude oil and the hot vapors in this exchanger or vapor separator 110.

The cracking reaction itself is quenched by the rapid drop in temperature of the cracking vapors, and the residuum is condensed out from those vapors. Simultaneously the crude oil has heated up to a point where the desirable portions were vaporized, which were called by Alexander the gasolines, kerosenes, solar oils and gas oils, so that a clean overhead stock
3689 is distilled out of this crude, this residuum withdrawn and the cracking reaction quenched.

There is an economic advantage in this particular type of operation because the high temperature of the cracking gases must be reduced, that heat must be subtracted by some kind of a condensation step if dephlegmation is to proceed, and instead of using water or air or something where the heat would be wasted in this case, the distillation of the crude oil is accomplished by making use of that heat.

Q. Does or does not the operation which Alexander teaches as occurring in his vapor separator or heat exchanger 110 satisfactorily clean the vapors that leave the exchanger and pass to the fractionating tower 117?

3690 A. In reply to your question, Alexander does not state specifically that the vapors leaving the top of the vapor separator are cleaned to any particular degree. However, he certainly teaches very dis-
3691 1856 tinctly the direct return of the heavier ends of those vapors condensed in the fractionating

tower to a tubular heater. And it was well known in his day that an oil containing residuum if vaporized completely in the tubes would leave a residue.

Now next, and this is my own opinion, Alexander shows his cold crude entering at the top of the vapor separator, and he shows it in the drawing of the patent (Fig. 8) as well as on the simplified drawing that I have prepared. It comes up the side line and shows sticking out into the top of that space.

Now Alexander does not say in that he sprays this oil into the top of the separator. On the other hand in the patent, and it is difficult to see from the patent drawing but it is visible, and we copied it as exactly
3692 as we could in the simplified drawing Exhibit 808, and the fact that that line extends much more than half way across the top of that space indicated to me, but does not prove, sir, that that was supposed to be sprayed down through there. It looks to me like a spray. If I had been doing it, I would have sprayed it.

Now if it were not sprayed, if that were pumped or forced so that the oil leaving the horizontal part of that line 111 burst against the far side of that vaporizer, it would splash and pretty well cover the vapor space with oil drops in any case. A far more accurate distribution of the liquid oil at the top of the vapor separator could be accomplished by spraying.

3692 1857 I think the drawing indicates a spray, and if it is a spray that means a given quantity of oil will fall down there in the form of drops or a fine stream which would contact the vapors coming up; and I can see no possibility of any suspended mat-
3693 ters, be there any entering the bottom of the vapor separator that could possibly go up through such a tower with the oil and come out of the top. Those vapors would be washed clean. I am certain that the vapors leaving the top of the separator would be clean, and that when they are condensed, and they are condensed in the fractionating tower, they will produce a clean recycle and a clean virgin gas oil.

Q. Now, will you continue with your description and correlation?

A. I will read again from page 6 at line 53:

"The heavy fractions or residuum of the crude oil together with the heavy oils condensed from the cracked vapors, pass out of the bottom of the exchange tower through line 114 to a storage tank."

The exchange tower is marked 110 in Figure 8 of the patent, and is labeled "vapor separator," and also marked 110 in the simplified drawing.

3694 The residuum is pumped from the bottom of the tower by a pump shown in the drawings of the patent, No. 115. This would indicate, certainly that the residuum from both sources was withdrawn and was not returned.

Now, I will read further from line 59 of the same page 6:

3694 1858 "The lighter oils vaporized in the exchange tower together with uncondensed vapors from the cracking tube are conveyed from the top of the tower through pipe 116 to the fractionating tower 117. Fractionating is accomplished in the fractionating tower by air, water or oil cooling."

I stated in my general description and of the simplified drawing, that some cooling of course takes place at the top of the fractionating tower to provide necessary dephlegmation.

Then I will skip a bit and read again on page 6, line 72:

"The vapors condensed in the fractionating tower are conveyed by pipe 120 to vaporizer or still 121 where they are again vaporized."

In Figure 8 of the drawings of the patent the still is shown, shell still 121.

3695 In the figure of the drawing the line 120 can be seen from the bottom of the fractionating tower leading to the end of the shell still. I am talking from Figure 8 of the patent.

Now the next sentence or two is interesting, line 75, page 6:

"Under usual conditions it is necessary to supply an additional quantity of oil to the vaporizer or still. Pipe 121-A is used to feed the additional fresh supply of oil. This pipe leads to a source of suitable material."

That pipe 121 and the pump 122-A is shown in the

drawing of the patent Figure 8, and is also
3695 1859 shown on this simplified exhibit or simplified drawing Exhibit 808, and is also labeled "clean feed."

3696 The line 121 is numbered in the simplified drawing with the flap down.

Q. Now why does Alexander feed this additional stock to the still, as described?

A. He is using the heat of his cracked vapors to distill from a crude oil this overhead gas oil that he is going to use for a part of the mixed feed to his vapor phase cracking process. The amount of heat which he has entering the bottom of this exchange tower is that in the transfer line and that only. Now depending on the crude, how much residuum there
3697 was present, he would be required to vaporize from that crude a larger or smaller amount of overhead and it might happen that the amount of heat he had available was insufficient to distill out of the crude all of the virgin gas oil he needed to keep his process running. If he added more and more crude in an endeavor to accomplish that result, that is to obtain an additional amount of virgin gas oil for feed, he would simply be throwing away residuum continuing a quantity of good stock which, if he had more heat, he would have distilled over. So it seems to me the balance of this process gets down to the amount of feed, the amount of crude oil that can be fed to the top of this heat exchanging tower. And then if that is not enough to operate the process he teaches that an additional quantity of oil must be supplied to the vaporizer or still and states in
3697 1860 the patent that the line from the pump 122-A leads to a source of suitable material. Now if he is pumping clean stock from the bottom of the fractionating tower, a mixture of clean recycle and clean gas oil to a tubular vaporizer, tubular still for cracking, a suitable stock would then, of course, have to be a clean overheadstock and his line to pump 122-A
3698 should lead to a source of gas oil or similar overhead clean stock.

If he is using the shell still with the flap up on the simplified drawing, as is shown in the Figure 8 of the patent that might not be quite as important. Certainly the preferable arrangement would be to

pump clean gas oil only into the shell still to match the clean feed that is being pumped from the bottom of the fractioning tower but he could, of course, put a dirty stock into the shell still with that clean feed without running into trouble. He would vaporize from the shell still the clean vapors for his cracking tubes, but would accumulate in his shell still some of the residuum which he might, if he chose to operate in this manner, introduce to his system through the line leading to pump 122-A. If that were the case he might use more than one of these shell stills. When one became dirty he could cut it out of the stream and supply vapors to his cracking tubes from another similar shell still, thus having at least one-on-stream and keep his process
3699 continuous. He teaches a continuous process.

I am led to suggest that that is a proper alternative for us to consider because in some of the
3699 1861 more complicated drawings and processes which Alexander describes, and in one in particular on page 5, in describing Figure 3, I will read from line 41:

"As in Figure 2, each of the stills is provided with a directly connected condenser. By this arrangement, presuming the plurality of stills are operated out of phase, one or more of the stills may always be furnishing vapors for cracking to the cracking tube while other stills are performing preliminary distillation;"

Now he does not say in there that he would use one still to produce vapors and create a heavy residuum and keep several stills in parallel but operating out the phase so as to supply vapors continuously, but I think a good operator would find that in the teachings of Alexander.

Q. Now will you continue with your description from the patent?

A. I will continue reading from page 6, skipping a bit to line 87:

3700 "The advantages of the apparatus shown in Figure 8, when employed in connection with crude oil are that such oil may be stripped of its lighter constituents by the heat of the vapors from the cracking apparatus thereby economizing heat."

Then I will skip a bit to line 95, which is the thought that I have already expressed, and reading: "The vaporizer shown in this view is a still similar to still 109 shown in Figure 7 but under some circumstances I may employ in lieu thereof such a special vaporizer as the element 75 of Figure 5."

3700 1862 The vaporizer, element 75 shown in this Figure 5 of the patent, is closely similar to the loop of tubing shown as 75 on the simplified drawing (DX 808) and labeled 75, the tubular vaporizer for vaporizing the oil to be cracked.

3701 There is no real difference at all in the operation of the process of Alexander as disclosed in DX 808 with the flap down and with the flap up. In both cases the clean stock is to be vaporized in some kind of a vaporizing unit, cracked in vapor phase in a tubular heater, and then the hot gases from that operation are put through a heat exchanger in counter-current relation to the cold crude oil so that the gas oil and recycle for the process is taken overhead as clean vapors.

3702 The element 75 shown in Figure 5 shows diagrammatically a tubular heater consisting of a single coil of tubing. If this single coil of tubing were replaced by a series of short tubes shown in parallel, I think that such a device for a vaporizing unit could be designed and could be operated successfully. However, I have indicated earlier in my testimony that engineering difficulties of design and operating diffi-
3703 culties so as to maintain uniform both the quantity of the oil flowing through such a parallel section to be vaporized, and the amount of heat supplied or the temperature to which these oils reached, must be closely considered or a result might occur in which one of these parallel tubes would be doing more than its share, it might be overheated and it might coke up. I believe it is possible to do it but I would prefer not to and Alexander teaches the use of a single continuous tubular heater for this purpose.

I now refer to the United States patent to Charles J. Greenstreet, No. 1,740,691 (DX 809), filed August
3704 the 4th, 1917, and issued December the 24th, 1929. There is a typographical error in the filing date on the face of the patent. That should be "1917" in-

stead of "1927". DX 810 is a copy of the
3704 1863 file wrapper of this particular patent to Green-
3705 street. In view of the complication of the apparatus we have some enlarged drawings (DX 811), photostats of the drawings of the patent.

3707 This is a somewhat complicated drawing, as Mr. Thiess has said, and the process which Greenstreet taught is complicated for the reason that he chooses to show and discuss not one cracking unit combined
3708 with one topping coil for the production of a clean distillate stock to be used in the cracking coil, but six of them all tied together. And I think just a word before I really start the discussion of the process, and state that these red and blue lines are put on because we are going to make a simplified drawing, in which that part shown blue and red and which represents one of these six cracking units and topping units will be taken off onto a separate sheet from which I am sure we can continue to talk about it with much more ease.

Now the tank 11-A in Figure 4 contains a sort of crude oil which is pumped through the lines running up to the circular spots on these lines marked 15.
3709 And those in this very diagrammatic drawing of Figure 4 are the topping coils, and he heats the oil in those coils, the crude oil in those coils, as he says in his patent, up to the vaporizing point of the benzine fractions. And those oils and vapors enter one of the tanks marked 22 which have several uses, perhaps a vapor separator describes them best.

3709 1864 Then if you will please come back to tank 11, another source of supply in this case an overhead distillate stock produced in the process, combined with a recycle stock, is fed through a pump and through six other series of lines. The little circles on lines representing tubular heaters and the first group down in the left-hand corner marked 10, are vaporizing tubes, and much or possibly even all of the vaporization of this stock is accomplished in these tubes.

Then the vapors, plus perhaps some of the unvaporized oil, goes through the three groups of little circles on the line marked 2 and which are also marked cracking coils.

3710 The teaching in Greenstreet is definite that cracking occurs almost entirely in the vapor phase and

leaving those cracking tubes 2 would be a stream of high temperature cracked vapors which combine with the heated crude that was pumped from tank 11-A just before they enter as a combined stream the tanks marked 22, which Greenstreet calls digester tanks and which I called a moment ago vapor separators, and from the bottom of those tanks 22—I am talking of tanks because there are six of them shown, and I want to recall that these are six independent processes that he has shown on this chart, and I could have said from one tank 22, near where the red line and the blue line enter because what I would say about one would be identical to what would be said about each or all,—from the bottom of the tank 22 is withdrawn a residue which is removed from the system and that resi-
1865 due consists of two things again, as it did in Alexander, the residue produced in the cracking operation of the distillate stock, together with the residuum naturally occurring in the crude oil.

3711 Now in these digester tanks 22, of course, further vaporization of the crude oil is accomplished so that the gas oil, the virgin gas oil of the crude oil is heated to the point where it vaporizes and is taken overhead as a vapor with the vapors not condensed that left the cracking tubes. The combined stream then of vapors leaves this first tank 22, or each of them if we are operating on six, in the direction of the arrow shown at the top of this Figure 4, and enters a series of tanks 24 to 31 which are described by Greenstreet as a series of digester tanks.

Condensation, some cooling and condensation occurs in each of these tanks, so that the heavier vapors are condensed and flow out of the bottom of these tanks into this red and black line at the top with the arrow again pointing to the left.

The non-condensed vapors in that series of digester tanks pass overhead from the last digester tank 31 to a final condenser 39 and is collected in 11-B and constitutes the desired final product, gasoline.

3712 Following this red line at the top of the Figure 2 down it will be noted that it leads to the tank 11 which contains a supply of distillate stock to be fed to the preheating and cracking coils.

3712 1866 Figure 4, your Honor, was submitted to the Patent Office a matter of years after the original

disclosure and drawings were put in, because the original drawings were so complicated.

3713 Now Figure 1 shows an elevation of this process, and Figure 2 is a plain view, and I think we will perhaps get more from this if we follow Figure 2 and refer occasionally to Figure 1.

Again the crude oil is in the tank 11-A which is circled in blue, and through the necessary pumps this oil is pumped to not one but six of the sets of coils in the furnace at the right of Figure 2. Only one pipe is shown for each of these coils. That is a plan view. You are looking directly down on it. The rest of the pipes are hidden.

I have shown in blue coming from 11-A following the pump, this crude oil coming down to the lowest of the coils which represent the topping coils, the coils shown as 15 in the Figure 4, and labeled 15 down at the bottom of Figure 2. If you will note, there are three lines leading from Figure 15, two of them lead-

3714 ing to the blue coil, the second one up from the bottom, and one of them leads from the bottom coil which is red. Well, they cannot all be right, so if the majority wins in this particular case, you are right. That is one of the changes that was made but still in error afterwards.

After passing back and forth through a length of coil in this second bank of tubes from the bottom,

1867 and which we are looking down on, the vapors come back and make a turn toward the bottom of the page, and then another horizontal turn and enter near the entrance to the lower of the digester tanks 22 as shown in this Figure 2.

Looking at the elevation drawing Figure 1, part of the furnace is broken away and you can count the return bends at the back side of the furnace. There are

3715 five of them, which would indicate for his long path through the furnace there were ten tubes. He states in his patent, which I will refer to later, and also shows on this diagrammatic drawing 4, that the cracking tubes are longer, the cracking tubes 2 are longer than the topping tubes 15.

Pointing to a tube that enters near the bottom of this tank, correlating the two thoughts shown on the drawing and his definite statement in the patent, I would assume that the cracking tubes made the whole

of the ten passes, taking care of the five return bends to these tubes and that the topping coils which are placed alternately with the cracking coils of this furnace, best shown in Figure 2, occupy a less space or do not come down to the bottom of the furnace.

3716 Now going back to tank 11 in Figure 2, this tank containing distillate, a pump is shown to force that oil in the first instance through the topmost tube shown in this drawing, Figure 2 and labeled 10, which we correlate with Figure 4, shows that as a preheating coil.

3717 1868 He states in the patent, and I will have to tie that up a bit later when I have the patent before me, that each of the cracking coils 2 has associated with it a topping coil 10, and he of course shows that in the diagrammatic drawing 4. Only one tube in this plan view, figure 2, is shown and marked 10.

I can only assume from that that the other coils 10, preheating coils, supplying each of the other cracking coils 2 are located underneath this single pipe that you can see marked 10, nor does figure 1 help on that because the preheating coils would be at the back of this view and again not visible.

After making at least one pass and return bend and back to the—as I face it, the left-hand side of the furnace—the preheated stock, and as Greenstreet teaches, largely or completely vaporized, leaves that tube and comes down underneath the others, and I have chosen to show it connected to the lowest tube of the several shown in this plan view figure 2.

3718 There would, of course, be similar connections from other preheater coils 10 for each of the other cracking coils in this complicated drawing.

After passing, then, through the 10 passes of the cracking coil 2, the lowest coil in this figure 2, the cracked vapors are taken down through the line marked 15′ and enter the lowest of the several digester tanks 22 shown in this drawing. Then, of course, at digester 22 the residuum is removed

1869 and the vapors leave and pass through the line connecting with the series of digester tanks 24 to 31, inclusive.

The arrangement of these eight digester tanks is most clearly shown in figure 1 above. The tank in

the middle of the figure 1, with the gauge on top of it marked 22, is one or all of these digester tanks 22, and coming off from it to 49 and leading down to 48, and then across a bit to the line that connects with the point marked 50, and going up and entering the side of tank 32, the first of that series of digesters, is the line carrying the vapors from the tank 22 to the first of these eight digesters.

3719 Greenstreet makes a big point of the insulation that he uses on all the piping and all these digester tanks throughout his process. We will discuss that in a little more detail later. However, some cooling despite the insulation occurs in each of these tanks, because he teaches the removal of a condensate from the bottom of those tanks. That condensate will be relatively heavy in the first tank and become lighter and lighter as it gets to the last tank, but he teaches combining all of them into the line shown directly under these eight digester tanks in figure 1, and which I have shown in red to make it clearer, and that combined condensate from those eight digesters he carries away back again to his tank 11, which is the same tank 11 shown in both figure 2 and in figure 4 and contains all the distillate stock which he
1870 puts through his preheating and cracking coils.

The last digester tank 31 is shown with a coil in it, in which he states he does any final cooling required to prevent heavy tails from coming over in his gasoline vapors, and he takes his gasoline out from the top of that last digester tank 31 and down
3720 through the valve 47. I haven't stated until now that that apparatus up to that point is maintained under a pressure and that valve 47 is the pressure control valve. That is, he does all his cracking and dephlegmating under pressure and then reduces the pressure and puts it through a condenser and condenses this final product in 11B.

The residue withdrawal from the tank 22 is best shown in the figure 1. At the bottom of this tank 22, with the gauge on it, is shown a line coming off from the side and going down through a valve to a point marked 41, and if I remember correctly that 41 is the header which runs across the whole length of these

tanks 22, so that this residuum from all is collected into a single line and removed from the process.

That withdrawal is shown on figure 4 just under the line of tanks 22, ending in an arrow pointing to
3721 the right. The cracking and topping tubes are in parallel banks across the furnace, first one and then the other, and that statement is almost correct but not quite. The tubes in these drawings, although the numbers referring to the tubes were changed a
1871 number of times in the various office actions, they never were entirely straightened out, and some of the numbers still point to the wrong tubes. The reason that that complication occurred was this: This bottom tube here is definitely one of the cracking tubes and then next is a topping tube, and the next is a cracking tube, and so on, but if you will look at figure 3 the cue to the difficulty is evident. This No. 15, referring to two or three of these pipe fittings above the valves, right in the middle of this drawing, figure 3, you will notice they are not symmetrically arranged across the page with respect to the other similar valves and pipe fittings shown in a row directly underneath and labeled 2. Beginning at the
3722 right hand side, there is first a cracking and then above it and next a topping, then a cracking, then a topping, then there are two topping coils together, so these coils do lie alternately if we begin at the outside as a cracking, then go to a topping, then a cracking, then a topping. We will end up in the middle with the two topping coils shown together.

Now, because the Examiner and, apparently, Greenstreet too realized that there was first one and then the other, they continued to mark these across here, every other one a cracking coil and the other a topping coil.

I don't see how that makes any great difference in this matter since it is very simple to pick out one pair of topping and cracking coils and discuss them,
1872 and he says that whatever happens in any one of them, it is the same as what happens in the whole of them combined together.

I now refer to a simplified drawing (DX 812) of
3723 this complicated apparatus. I will first generally correlate this simplified drawing which I have prepared, with the simplified drawing in the Greenstreet

patent, figure 4. The crude oil, which is the primary charge to this process, is contained in the crude oil tank 11a on the simplified drawing, Exhibit 812, and of course is shown as 11a on the figure 4 of the patent.

A pump is indicated on the figure of the patent and shown diagrammatically as a feed pump on this simplified drawing. That oil forced by that pump goes through the topping coils where the temperature is raised to the vaporizing point of the benzine fraction, and it enters then the single vapor separator tank 22,
3724 digester tank or vapor separator tank 22. The rest of the tanks 22 are not shown, since the teaching is specific to have one of them for each pair of topping and cracking coils.

Now, going back to the tank 11 labeled "Reflux tank" in the simplified drawing and merely labeled 11 on figure 4 of the patent, in both cases a pump is shown. It is marked "pump Figure 12" in the patent and marked "Circulating Pump 12" in the simplified drawing, and I have chosen to show instead of a square representing a pump of some kind in the drawing a diagrammatic pump in this simplified sketch.

This pump 12 pumps the charge to the pre-
3724 1873 heating coils from the reflux tank 11. The preheating tubes are shown as the first loop at the top of the furnace marked 10, and they come back and outside, and there is shown a steam connection which, for the sake of simplicity while referring to the general operation, I didn't mention.

The steam pipe is the pipe 14 shown in yellow on Figure 2 of DX 811, and coming down, and goes to a section of the furnace, as Greenstreet teaches, to superheat the steam. He wants the steam good and hot when he mixes it with his oil vapors. Just how that connection is made after it comes out of the superheating step in the furnace is rather difficult to say, but he teaches that before the vapors from the preheating tubes are allowed to enter the cracking coil that a certain amount of the steam is introduced.

The circulating pump 12, after pushing the oil through the preheating tubes and vaporizing it and being mixed with some steam, enters the cracking tubes 2 at the lower righthand corner of this simpli-
3726 fied drawing, and then comes back to the digester tank or vapor separator, as I have marked it, 22.

To clarify that, your Honor, Greenstreet does not call it a vapor separator. He calls it a digester tank. That is my interpretation of what takes place in it and I put that on, I thought, to make it clearer.

I note that valves are shown on the lines coming from the topping tubes to this tank 22 and also from the lines coming from the cracking tubes to tank 22. I have labeled them pressure valves in the
1874 simplified drawing, and on the Greenstreet drawing they are not labeled but simply shown as valves. When I said the Greenstreet drawing I meant on the patent figures of the Greenstreet patent.

Now, the residue drawoff from this digester tank 22 is shown coming down at line 41, and broken away is shown a header which would go to the rest of these tanks 22 if we were discussing the whole of them at once, and I have labeled it, "Residuum drawoff." In the drawings of the patent there is no such label
3727 attached to it, but these specifications are quite specific in teaching that it is a residuum drawoff.

Then coming out of the vapor separator through a valve 49 and down again to a header 48 is shown a vapor line leading to the series of eight digester tanks. That header is again shown there broken off because Greenstreet teaches the use of a series of these digester tanks 22 and then combining the vapors from these several tanks representing his six topping and cracking processes in parallel, and putting the combined vapors into this header 48, and all these vapors at once through these digester tanks 24 to 31, inclusive.

He also makes a statement later on that he doesn't want to be held tightly to that but that he might choose to have a series of eight tanks for each of his individual topping and cracking operations. So just for the sake of convenience this header 48 was shown broken away on this vapor line, and there is also a header shown broken away on the residuum
1875 drawoff line.

The vapors enter the bottom of the first of the eight digester tanks 24. These tanks are not shown
3728 insulated nor is the piping shown insulated, but it is clearly taught in the patent. Some cooling and condensation, despite this insulation, occurs, and it is readily seen that the vapors from the top of the first

digester tank 24 are carried through sloping pipe 32 to the bottom of the next tank, and that this step is repeated to the last one.

Connections are shown at the bottom of each of the eight digester tanks leading to a header 42, which I have labeled "Reflux header" but which is not so labeled on the drawings.

That is descriptive of what that line carries. It carries a reflux condensed out in the digester tanks 24 to 31, and I would agree it does not tell the
3729 complete story because there is also present some virgin gas oil stock. I don't recall having found that term in the specification.

The combined condensates removed from the bottoms of these eight digester tanks in series are led through the pipe shown at the left side of the picture of the simplified drawing up to the tank 11.

Now, there is a no cooling shown in that line leading from the bottom of these eight digester tanks to tank 11, and if we refer to figure 2 of the patent there is no cooling device shown on that line. On the other hand, in the patent Greenstreet suggests that
1876 that be put through a condenser, which I think we will have no trouble in agreeing was a misnomer. He really meant a cooler, but he didn't ever correct his drawing and he never stressed that matter thereafter, so I copied the drawing in this case and have not shown such a cooling device.

3730 Mr. Thiess: Q. Now, referring to this simplified drawing, will you describe the process which Greenstreet teaches in his patent?

A. Well, Greenstreet teaches the production in this process of an overhead distillate stock from a crude oil which, together with the reflux obtained from the cracking operation, serves as the only feed for a vapor phase cracking step. The hot vapors from the cracking tubes are used to distill out of preheated crude the desirable components, and he accomplishes the step of quenching his cracking vapors and cooling them with this preheated crude at a lower temperature, of course, than the cracking gases, removes from the digester tank 22 the residuum from both sources, and conducts the vapors from that tank through a series of digester tanks or, as I prefer to

consider them, fractionating apparatus, so as to condense out the incompletely converted heavier oils.

Those heavier oils are returned to the reflux tank 11 and constitute the charge for the cracking operation. The vapors not condensed in the series of
3731 digester tanks are, as usual, carried over to a final condenser and receiver.

Several things occur in the tank 22. The vapors from the cracking tubes at a high temperature
1877 are cooled by the mixed vapors and oils at a considerable lower temperature coming from the topping tubes. As this oil from the topping tubes mixes with the vapors from the cracking tubes it, of course, is heated up and much of it vaporized, so vaporization of materials coming from the topping tubes occurs in 22. Condensation of the heaviest materials entering 22 from the cracking tubes results.

Residuum is separated and withdrawn coming from two sources, as I have described, and the vapors of the gasoline produced in cracking and of all the vapors vaporized from the crude are carried over to the series of digester tanks, the heavier part separated out to be sent back as the only source of material for the cracking operation and the final product taken overhead and condensed.

3732 The operation which I have given in connection with this simplified drawing (DX 812) is best described in the patent on page 2 at the top of the second column, line 69:

"The crude oil is first run from the tank 11a," as I am sure was clear when we considered the enlarged patent drawings as well as the simplified drawings,

"through the topping coils and during its course through these coils 15 which are located in the furnace is heated to at least a point above the vaporizing point of the benezine fraction."

I have made that same statement a couple of times before and it means, of course, heating the crude oil until some part of the gasoline—because I am
1878 sure that is what he means by benzine—has changed state and become a vapor. Whether he means the first few bubbles of vapor that would be produced when the lightest parts of the gasoline were vaporized, or whether he means every last bit of it,

I don't know, and I think we shall probably show later it is not too important. The point is, it is
3733 preheated up to a point, some temperature, depending on how much of that gasoline that was converted to a vapor he meant, but something around, let us say 400 degrees Fahrenheit.

"These vapors are then conducted through the vapor lines 15", and that is shown on the simplified drawing and I called your attention to that same number on the enlarged drawings of the patent a few moments ago, "to the digester tanks 22 and from these tanks into the header 48", which I have explained on the simplified drawings I have shown broken away since we are showing only one of these tanks 22, "and from these tanks into the header 48, and thence successively through the series of digester tanks 24-31. During the above defined course, the tars or asphalts settle out in the digester tanks 22."

I said that in other words. I said that the residuum produced in the cracking of the overhead stock in the cracking coils was condensed and that it separated from the vapors in the tank and settled to the bottom and was withdrawn, and that the residual
3734 materials from the crude which entered the tank together with the hot gases from the cracking were not vaporized, that only the valuable portions were
3734.1879 vaporized, and so these residual materials in the crude would also settle to the bottom of the tank and be withdrawn. These tars and asphalts settle out in those tanks because, of course, they are fairly heavy materials and in any case liquids and, therefore much heavier than in vapors around them, and they settle by gravity. The velocity in the tank of course being so much less than that in the tubes they have no trouble in settling down against any velocity of vapors in an opposite direction.

Continuing with the reading, line 81, page 2, "and the vapors continue on down through the series of tanks 24-31. * * * a portion, comprising in each case the heavier ends, of the vapors from each tank being
3735 condensed in, and collecting in, the next succeeding tank. The last tank contains only benzine vapors, which are thence led to the tank 11b."

That is the storage tank for his final product. "The

condensed products which are led into the header 42 are then conducted through pipe 42 to the distillate storage tank 11." I have called it a reflux tank. I think I might have done better to have called it a distillate storage tank. In fact I wish I had. "The oil is conducted from the storage tank 11 into the preheater coils 10 and is vaporized approximately upon leaving the preheater."

I again don't know, your Honor, whether that means the whole of it or most of it or part of it, and I don't think it matters much, because if it is not completely vaporized in the preheating coils by the time it gets over to the cracking coils it
3735 1880 will shortly be vaporized. The more heat he can put into his oils and the more completely he can vaporize them in the preheating coils the less work he will have to do in his cracking coils. Just
3736 where the point of complete vaporization may occur I don't know and I don't think that statement teaches it exactly.

"It is then conducted in vapor form," of course that indicates it was pretty largely vaporized at that point, maybe completely,

"and accompanied by steam through the cracking coils 2 where it is heated to a high temperature under pressure."

Then he makes the remark about blowing steam through the apparatus before he starts up.

Now I will skip a bit down to line 108:

"By the use of the process as above described, the heavier fractions which are not transformed into lighter fractions in the cracking coil, due to the rapid velocity of the contents through the cracking coils, are converted into lighter fractions during the course of the vapors through the various digester tanks," referring to the series of eight, 24 to 31 inclusive, "so that upon leaving the digester tanks, an unusually large percentage of the oils is transformed into lighter hydrocarbons and due to the heat insulated passage through which they are conducted, the fuel consumption for heating the oil under treatment is
3737 greatly reduced and due to the prolonged exposure of the particles to a high temperature while under pressure, the unusually large conversion above mentioned is accomplished."

1881 Q. Now, will you explain that?

A. First of all, that is the only passage in the patent, which is fairly long, that insists that additional conversion—that would mean cracking—occurs in this series of eight digester tanks. Greenstreet is very keen on this insulating matter. In fact if I may read his objects given on page 1, line 4:

"One of the objects of my invention is to reduce the cost of operation of processes for cracking hydrocarbon oils, and is especially useful in reducing the fuel consumption and increasing the percentage of light hydrocarbons recovered with a minimum amount of labor.

"One way of accomplishing this result is by heat insulating the passage from the furnace to the exit."

3738 I will refer again to page 1, line 75, one other place, and I am sure there are others beyond that:

3739 "The digester tanks 22 and all other parts of the pipe system and tanks are heat insulated by some suitable compound 23 in any well known manner. All the digester tanks",

and I will skip a bit, and so forth,

"are heat insulated."

He stresses that through the specifications, your Honor, and he obviously had a theory that he was going to obtain in these digester tanks additional cracking, and that despite the fact that he teaches reducing the temperature of his cracking vapors at the entrance to the first digester tank 22. He teaches quenching that cracking operation by mixing

1882 with it crude which has been heated to a very much lower temperature, perhaps 400 degrees, and perhaps his vapors coming from his cracking tubes were 1,000 degrees. He must drop that temperature to some point between those two, and cracking in tank 22 would be at a minimum. If the temperature in tank 22 were between 750 and 800 degrees, and I am giving it a range as I have no way of knowing exactly—I don't know what crude he is using and I don't know a lot of things, but it will be something

3740 in that vicinity—it would be a low rate of cracking and it would take a long time to get even one or two per cent additional gasoline yield.

On top of that, sir, he teaches withdrawing the condensate from each of the following digester tanks,

despite the fact that they are insulated and the piping as well is insulated, and as I say he makes a great point of that. He teaches that condensation occurs, therefore cooling occurs. You can't have condensation in the tanks without cooling, and if the temperature drops going through those digester tanks, each of those tanks in turn will be lower than the one before, and all of them will be lower than tank 22.

The function of the digester 22 of Greenstreet may be compared with the function of the heat exchanger 110 of the Alexander patent.

In both cases the effluent from the high temperature vapor phase cracking coil is contacted with a crude oil from which is to be distilled the valuable fractions as vapors, and which the combined
3741 1883 residuum from both sources is to be withdrawn.

In the case of Alexander he used a crude oil which had not been preheated, and therefore he was required to use less crude oil than Greenstreet can use in his device where he preheats the crude, because obviously when the crude has been preheated, since it is at a higher temperature more of that crude will be required to produce the desired quenching action. Thus by preheating his crude Greenstreet is able to produce as an overhead product all of the charging stock for his cracking process, whereas Alexander, in using the cold crude, at times, at least, failed to produce all of the charge he needed and taught the introduction of a suitable charge along with that recovered from the system.

Of course that does not necessarily prove that Alexander was wrong or that he missed a bet. He might have just considered it was equally simple to produce this other charge in a coking operation somewhere, since in those days crude distillations producing such gas oils were a part of most refineries.

3742 Greenstreet mentions pressure a number of times, but if I recall correctly he does not state any specific pressure. For example, on page 2, line 13, I will read:

"Each of the digester tanks is provided with a pressure gauge so that the pressure may be observed. This pressure is controlled by a valve 47,"

which I have pointed out on the patent drawing,

1884 the enlarged patent drawing, occurred just at the end of the final tank of this row of digesters and which I have marked "Pressure valve" on the simplified drawing, Exhibit 812.

Then at the bottom of that same column, page 2, line 59:

"Since the process is carried out under pressure," and again in the second column, line 96:

"Where it is heated to a high temperature under pressure,"

and again at the bottom of that column, line 123, "to a high temperature while under pressure."

3743 I think there are other places too where he mentions that, indicates that he intended to use some kind of pressure, although I haven't found and I don't think I will find an exact statement of his preferred pressure.

Considering the process as a whole, Greenstreet can't have a uniform pressure throughout his system. He shows two sets of tubes, one the topping tubes which he teaches as shorter than the cracking tubes, and the other set of tubes, the cracking tubes, in connection with which he has some preheating tubes.

3744 Thus he has two paths through his furnace, one long and the other short.

Next he teaches heating the crude oil in the topping coils to a point where some vaporization occurs and teaches completely vaporizing and cracking the

1885 distillate oils in the other longer coil.

Now I am sure there can be no argument that the resistance through those two paths will be quite different. Not only would the resistance in the cracking tube be greater than in the topping tube because it is longer, but because so much more vaporization is required to carry out the Greenstreet teachings. Therefore either the circulating pump 12, forcing the distillate material from the tank 11 through the preheating and cracking tubes, either that pump would have to operate at a higher pressure than the corresponding pump 12' taking crude oil from the tank 11a and passing it through the

3745 topping coils—if at the point where the two streams meet just before the entrance into tank 22a, if at that point the two pressures are to be alike, in other

words, if at that point the pressures are to be alike, the pressures measured directly after these two pumps 12 and 12′ would have to be different or, conversely, if the pressures measured directly after the two pumps 12 and 12′ were alike then the final pressure just before these two streams combined to enter tank 22 would be quite different.

Greenstreet does not teach which he meant to have the case. He shows the two valves just before the two pipe lines combine and enter the tank 22, which I have marked "Pressure valves" on the simplified drawing Exhibit 812, and which are not marked but which are shown at that corresponding point just before each of the digester tanks 22, best shown in the figure of the patent, figure 2.

3746 1886 Now, I can only assume from that that he meant those two valves to have a useful purpose and that he wanted to prevent anything happening like some of the crude oil arriving at that valve just before tank 22, and partially vaporized, and arriving at a higher pressure, let us say, than the vapors from the cracking coil 2 arriving at the other valve. Certainly he does not teach that any of the crude oil should flow into that line 16 leading backwards to the cracking coil. Of course that could only happen momentarily because the pressure would then build up and they would flow on together, but I assume that those two valves were to regulate the pressures coming from those coils so that there would be no return flow through either and that the combined oils and vapors would enter tank 22. Greenstreet refers to steam at the bottom of page 1, line 51:

"Connected with each cracking unit is a steam pipe
3747 14 which pipe is so arranged that the steam, before entering the cracking unit, is superheated. This steam pipe also has suitable valve connections for controlling the flow of steam."

He doesn't explain in detail why he uses it, but many of the patents of that time disclose the use of steam mixed with the oil. It was the general idea that this seemed to cushion the cracking reaction, and some people may have thought that they obtained a water gas reaction to remove the carbon from the tubes when that happened. I can only say that during

that time steam was sometimes used. He suggests using it and he does not say why.

Mr. Hall: Do you mean it was used or was described in patents?

The Witness: I said described in patents.

1887 I don't myself know the place where that was
3748 used commercially. As to the temperature that would be used in the operation and process that Greenstreet discloses, I don't think he gives an exact temperature as to either his cracking operation or his topping operation, but since he is talking of vapor phase cracking and since he is using a stock comprised of all the valuable materials which he would distill out of his crude, I should think he might be anywhere between 900 degrees and 1,000 degrees at his cracking coil outlet, and I suggested that I thought his topping operation as it leaves the topping tubes might be as high as 400 degrees, not knowing whether he means to vaporize the entire amount of his gasoline fraction or not, and not knowing how much gasoline he has got there.

Now I have referred to the part of the description on page 2, beginning with line 103, in which Greenstreet talks or describes that he might get some additional cracking in the digesters 24 to 31.

3749 The amount of cracking that would occur in the digester tank 22, or the following digester tanks 24 to 31 would, of course, depend on two things, depend on the temperature at which these vapors are held in those digester tanks and, of course, on the length of time that they are there.

We have no data given in the patent specifically stating the size, which would mean the time if we had the rate at which the oil went through, or the temperatures of these tanks. We can only reason
3749 1888 from the other data given and from the fact that in the tank 22 Greenstreet teaches the withdrawal of a liquid residuum.

Now, if the tank 22 by any combination of circumstances were at too high a temperature this residuum would become heavier and thicker and would be difficult to withdraw and might give him trouble, so there is a limit to how hot that tank 22 can be.

Next, his cracking temperature not being definitely stated, but since it concerns a very heavy gas oil, pre-

3750 sumably all of the valuable materials in the crude, it would hardly be at the top end of the scale, but it is at a good high temperature and it is in vapor phase when it is cracked.

3980 If we take a cracking temperature in the vapor
3981 phase but not the highest one because of these high oils, from 900 or 950 even up to 1000 degrees possibly, for the vapors from the cracking coils and a temperature of 400 or possibly even a little higher although the patent is not specific as to what the patentee means by the vaporizing point of the benzene fraction, whether it is the beginning or the end, it seems to me that the temperature in this digester tank 22 would be in between those two limits, and I should think somewhere between 800 degrees as a top down to about 750.

I am keeping in mind an important matter in making those temperatures as they are. The crude oil which Greenstreet is preheating and pumping into this tank 22, contains its own natural gasoline component, so the vapors leaving that tank have gasoline from the cracking coils as well as gasoline from the crude, and we have seen in the various discus-
3981 1889 sions and testimony here in this case that an important lifting effect, a partial pressure effect of these light vapors is evidenced when the gasolines and the cycle stock, we will say, are vaporizing to-
3982 gether. Now with this extra amount and the more than double amount of gasoline you get from cracking, the partial pressure or lifting power, the effect of the partial pressure of the low boiling constituent would be greater and there is a real danger that Greenstreet might strip his residue to such a point that it would be too thick. Therefore, I do not think that 800 degrees is a reasonable temperature; I think it is too high. I think 750 is a fairer temperature for the digester tank 22. And of course, since condensation occurs in the succeeding digester tanks the temperature is lower in each succeeding tank, and at 750 degrees cracking itself—the cracking rate is low in any case and perhaps 4 or 5 per cent per hour. And here we have a low cracking rate and the material progressing through as vapors, so the rate of flow of the vapors, of course, is high contrasted with what it is with the oil. So I should think the time factor and the tem-

3983 perature both pointed to a small insignificant amount of cracking in tank 22 and much less in each of the succeeding eight digesters of the Greenstreet patent.

3751 1890 Since the digesters 24 to 31 inclusive are each somewhat cooled, at least the contents of them become somewhat cooled in order to produce the condensation of some of the heavier fractions, which Greenstreet describes, I would conclude that each of the tanks 24 to 31, inclusive, would be somewhat lower in temperature than the tank 22, and that less crack-
3752 ing would occur in each or any of those eight digesters than in the tank 22.

In the specification as originally filed Greenstreet made a statement with respect to the character of the condensate withdrawn from the first three digesters which we should consider. If it had not been cancelled it would have occurred on page 3, at the end of line 28. The statement that was cancelled, reads:

"I have found in practice that tanks 24, 25, 26, contain a very superior lubricating stock entirely free from paraffin or other carbon."

3752 1891 The first office action, paper 2, page 2, pointed out that that was an error; that since paraffin was not a carbon the word "other" should be stricken out, and that was done.

Then in the file wrapper which is in evidence in the official paper No. 4, written by the Examiner No-
3753 vember 19, 1918, on page 3, the first full paragraph—I will read the paragraph to which I am referring:

"It is left wholly uncertain what connections would be employed or what conditions would be observed in the practice referred to in the last paragraph completed on page 7 or in the next to the last paragraph on page 8. These paragraphs should be cancelled for they could not be made to convey actual information without exclusive reliance upon new matter."

The reference to the last paragraph on page 8 of the specification was that line which I read and which was cancelled.

In his reply to that remark of the Examiner in the Paper No. 6, dated January 17, 1920, and on page 9 of that paper, the middle small paragraph, I will read:

"The corrections to the specification have been

made and the alternative matter referred to at the bottom of page 4 and the end of page 8 has been cancelled so that the specification is now without objection so far as we know."

3754 In other words, Greenstreet made no further comment than simply to cancel it. However, I feel that is a very important statement that he makes because it is not just a casual thing, it is a statement of fact; he says, "I have found in practice" that the condensate from those first three digesters in a row 24, 25 and 26, were the hottest ones. He has found

3754 1892 that they contain a very superior lubricating stock entirely free from paraffin or carbon, and I think I am fair in leaving out the word "other" which obviously does not belong in there.

If your Honor please, lubricating stock must not contain asphaltic residues and tars. Yet he says he has found, and that certainly must mean he saw some of the stock.

In some way, whether he saw it or not, he found it was a pure lubricating stock.

3756 When I read that I considered that to be a fact statement that Greenstreet had found a lubricating oil in these first three digesters, the hottest of the series of eight, and when he specifically states beyond that that not only was it a lubricating stock but that it was entirely free from paraffin or carbon,—and by paraffin he certainly means the crystals of paraffin which are present in many lubricating stocks and which are generally removed before the material becomes a satisfactory lubricant,—when he says he found no such material there, I can only assume that there was no asphaltic tarry material present or he could not have considered it a very superior lubricating stock.

That statement originally present in the specification as filed confirms me in my belief that little or no cracking was taking place in those digesters 24 to 31 inclusive, particularly covering the first four which

3757 are the ones with the highest temperature where, of course, the bulk of any incipient cracking which

3757 1893 may have taken place would have taken place.

I can only conclude that my statement made earlier this morning was correct and that the crack-

ing, if any, would be so slight as not in any way to interfere with the quality of the condensate produced in these digesters.

Q. What does Greenstreet say with respect to these other tanks that would justify your statement that no cracking occurs in the digester tanks?

A. I will refer to the top of the first column on page 3 and read:

"In practive, I have found that when, as shown, about eight tanks are used the last three or four tanks would act in the capacity of a fire still, the heat in the tanks being higher than the volatilizing point of the benzine causes a distillation from these tanks over to the last tank, so that the distillates separating out in the last three or four tanks contain no benzine and
3758 should the last tank contain too much of the heavy ends, due to the benzine carrying over mechanically some of the heavy ends distilling, the cooling coil in the last tank serves to precipitate out the heavy ends, and the benzine vapors pass into a condenser coil," and so forth.

It would seem from that statement that the temperature in the last three or four tanks of the series of eigth was not only lower than the cracking temperature but apparently not much more than the temperature at which benzine would distil. He makes no specific statement as to the temperature of the tanks. The benzine would distil out of that stock at tempera-
tures between 400 and 500 degrees, perhaps,—I
3758 1894 don't think we can be specific on it,—and that whole section that I have just read makes me think that these last three or four tanks actually act, as he suggests in the patent, in the capacity of a fire still where the body of the oil is maintained hotter than the vapors which come overhead, but at a temperature perhaps 50 or not more than, I would say, 100 degrees higher than the temperature at which those vapors would boil.

3768 I am very certain in my opinion the temperature is too low and the time too short to have any cracking in these digesters 24 to 31 beyond a small incipient amount which would in no way affect the quality of the heavier oils condensed and to be used as a recycle in this particular operation.

If a large amount of cracking did occur in these digesters 24 to 31 inclusive, that reflux condensate
3769 would not be a suitable charging stock for a vapor phase cracking process.

If a large amount of cracking took place in these digesters 24 to 31 inclusive, a large amount of residuum would be formed and such residuum would not be vaporized completely in the vaporizing and cracking coils of this vapor phase operation, and choking of the tubes would result and the apparatus and operation would not be long operable.

In my last answer I stated that the stock would not be a suitable charging stock for a high temperature vapor phase cracking process. I intentionally limited my answer to such a process because if the stock were contaminated by even a considerable amount of a residue, and it were used for a
3769 1895 cracking process of the type where some of the cracking and most of the heating were done in tubes but a body of oil maintained at a distance somewhere else, that would be a satisfactory stock for such a cracking process.

Q. Now, if a small incipient amount of cracking
3770 would occur in the digesters 24 to 31, inclusive, would the condensate collected in the digester be suitable for charging to the Greenstreet process?

A. If by "incipient" you mean the amount that I consider possible at these low temperatures and time periods, I am sure that that small amount of residuum from such incipient cracking would in no way interfere with the use of this material in the Greenstreet process.

Q. Based upon your personal experience in the prior art, will you please discuss how, if any, the temperatures used in cracking processes varied from time to time?

A. The earliest cracking was directed at the production of kerosene as a major product, generally at atmospheric pressure, and temperatures were low, perhaps 700 degrees. Then Dewar and Redwood applied pressure to their still and therefore, of course, raised the temperature somewhat in order to have the kerosene distil.

Then later the gasoline was the desired product and

generally higher temperatures were employed. In fact
3771 in the vapor phase processes of this prior art, the temperatures have gone as high as 1050 or possibly 1100 degrees Fahrenheit.

3771 1896 The general trend of temperature for cracking through the years since cracking first started has been upward. There is a difference in the product produced in this wide range of temperatures used in cracking. Thinking of gasoline as an example, the gasoline of Burton's time would have a relatively small percentage of these olefins which he mentioned in his patent, perhaps two per cent or three or four per cent, of course, depending on exactly what was done at the time. The gasolines produced by the processes of the type which Mr. Smith referred to as a fireless cooker type, where the temperatures were intermediate, such gasolines might have, would have a higher percentage and it might vary between 10 and perhaps 15 per cent of these unsaturated loosely grouped as olefin products.

3772 Then the vapor phase gasoline, such as Hall disclosed, for example, would have a much higher per cent of unsaturated, possibly might run 30 per cent or even higher, and these unsaturated bodies have much to do with the characteristics of the fuels themselves, both as to the color and odor. I do not say that these unsaturated bodies make the color, but the color is associated with the high unsaturated percentage, and the anti-knock value of the gasolines definitely increase, other things being equal, with the per cent of unsaturates.

Some of the earlier patents, notably that of Benton, had a very high pressure for his day, 285 pounds, but in general the early cracking processes were at low pressure and they have gradually increased as
3772 1897 the years have gone by. Of course the vapor processes today may or may not have a high pressure.

3773 As to the trend in equipment, so far as improvements in the materials available, we have the alloy steels to-day for cracking tubes that we did not used to have. There have been improvements in pumps, in gaskets, in fire brick, and I understand that carborundum is made in brick form and will serve as a su-

perior lining for such a setting. Instruments, of course, have improved, control methods, there has been a certain and positive improvement as the years have gone by.

Like most of the other things that we have just mentioned, the capacity of the units available for commercial work has increased. The Burton still, for example, held 200 barrels or a little less of oil, and that took a day or more to be cracked and another day perhaps to be cleaned.

Then the first of the types of cracking units, where the heat was put into the coil and where the bulk of the oil was held in a reaction chamber, the first of those
3774 units was perhaps 500 barrels and they increased as the years went by to a thousand or two thousand, and some of the cracking units today handle 5,000 barrels of charge in a day.

Q. At the time that you became actively associated with the commercial cracking process, what if anything was the condition of the art with respect to the character of the charging stock fed to the unit and the still?

A. When I became actively interested in com-
3774 1898 mercial cracking, which was about '25 or '26, when I first began spending considerable time at the refinery of the Magnolia Petroleum Company in Texas, there they had Burtons which required a clean charge of gas oil, and Cross units to which was fed a distilled product, a gas oil, since that was recommended by the manufacturers and licensors of the process.

At that same time there was in use in many of the refineries and being offered to the trade, the Dubbs Process which made a point of the fact that such a
3775 clean overhead distillate need not be prepared as a charge for the Dubbs cracking process, it would handle the reduced or topped crude, fuel oil, or similar materials that contained residuum.

As a man skilled in the art, it is my understanding of the meaning of the word "vaporization" that it means a change of state, either from a liquid to a vapor or from a solid to a vapor. I have never that I can recall used the word "vaporization" in any other way than I have just defined it.

I have so used the word "vaporization" in the testimony I have here given.

As a man skilled in the art, I do not consider vaporization a two-step process consisting first in vapor generation and second in vapor separation. When a liquid is converted into a vapor, vaporization is completed.

1899 *Testimony Under the Rule.*

3776 Q. I now wish to refer you to Exhibit 528, Pyzel patent No. 1,506,444, and particularly to page 1, beginning at line 97, where the patentee says: "I have found that in the operation of cracking stills, the temperature must be maintained at such a high point that a considerable portion of the residuum delivered through the pipe 20 is vaporized as soon as the pressure is relieved, this vaporization being assisted by the addition of steam. In the separating chamber 25, these vapors are taken off, a greater portion being eventually delivered into the storage tank 34."

In the statement just quoted to you from this patent, does the patentee use the word "vaporization" to mean "vapor generation", "vapor liberation" or both?

3776 Mr. Hall: Now if your Honor please, we have conceded in this case that "vaporization" may mean "vapor generation." That is one of its meanings. Having conceded that, how is it pertinent to take up all the uses or all of the documents or all of the patents where the word may be used in that sense, and present it to your Honor?

3779 The Court: We have had the term defined by various witnesses, including the present witness, by various witnesses who were experts. They have given the definition and it has been stated—the concession has been made that Mr. Hall has just mentioned, so that I do not see that it is helpful at all to have an interpretation of this or any of the other patents.

3779 1900 Mr. Denison: Mr. Pyzel answered,—I did not hear the deposition read but I am informed he gave his interpretation of this word in his patent.

Mr. Thiess: To mean vapor generation.

Mr. Denison: That is right.

Mr. Thiess: Then it was objected to when we were reading the testimony, the deposition at the time that they were being read here.

The Court: If it were not for the concession, I think possibly it might be pertinent, but I do not see that it is in view of the concession that it may mean "vapor generation", and if it were shown that the patentee here uses that term in the meaning of vapor generation, it would not add anything.

3780 Mr. Neuman: Well, it throws light on his testimony where he uses the word in the plaintiff's sense and on cross examination we were not permitted to impeach him and show that—

The Court: At some other time—

Mr. Thiess: That he used the other meaning.

Mr. Hall: You cannot impeach him by showing at some other time he used some other meaning, if it has two meanings.

Mr. Neuman: He was instructed not to answer.

The Court: If it has two meanings, as Mr. Hall says you cannot impeach him by showing it was used in some other way. If it goes in at all, it will have to go in under the rule.

3781 A. There can be no doubt as to the specific meaning in this case because he points out that as soon as
3782 the pressure is relieved vaporization occurs.
1901 Pressure will prevent vapor generation. I fail to see how it can prevent vapor separation, therefore in this case certainly vaporization certainly means vapor generation.

3783 Mr. Thiess: Q. I also refer you to the Pyzel patent 1,891,318, Exhibit 529, page 3, beginning at line 31, which reads: "A relief in pressure would naturally result in an immediate vaporization of the lighter and more volatile portions of the oil." In the statement just quoted, does the patentee use the word "va-
3783 1902 porization" to indicate "vapor formation," "vapor liberation", or both?

A. There again "vaporization" is tied up with a reduction in pressure. Such a lowering of the pressure would permit increased vaporization and vaporization could only mean there vapor generation.

Q. In the same patent, page 3, beginning at line 46, reading: "This deposition is prevented by the

immediate injection and mixing of cold oil with the mixture of hot products leaving the reaction coil. This injection not only cools the mixture and thus prevents vaporization of the more volatile oils contained therein but it also supplies additional volatiles from the settling tanks which volatiles have been in a measure freed from their solids and semi-
3784 solids by settling." In the statement just quoted from the patent, does the patentee use the word "vaporization" to denote "vapor formation", "vapor liberation", or both?

A. Well again he suggests that the introduction of the cold oil will prevent vaporization. As the temperature is lowered there is a reduced tendency for the liquid to change state and become a vapor. There again "vaporization" means vapor generation.

Q. I now wish to refer you to the Pyzel patent No. 1,622,737, Exhibit 530, page 2, beginning at line 114, which reads: "Due to the reduction in the partial oil vapor pressure inside the rerun still 21, which is due in turn to the presence of steam, I am able to evaporate such low boiling point vapors at this
3784 1903 lower temperature, the latent heat of vaporization being supplied by heat conduction from the liquid in the tubes 24." In the statement which I have just quoted from the patent, does the patentee use the word "vaporization" to indicate "vapor formation," "vapor separation", or both?

A. Well, he refers to the latent heat of vaporiza-
3785 tion. Of course, that means the heat required in the change of state and this change of state has to do with vapor generation.

Q. I now wish to refer you to the Pyzel patent No. 1,597,821, Defendant's Exhibit 525, at page 1, beginning at line 90, which reads:

"As a result the latent heat of vaporization of such vapors is always very low and small changes in conditions in the apparatus will result in wide variations in the amount of condensate produced."

In the portion of the patent just quoted, does the patentee use the word "vaporization" to indicate "vapor formation," "vapor liberation" or both?

A. My answer would be the same as the last. He refers to the latent heat of vaporization which re-

fers to the change of state, therefore of course the vapor generation.

3785-6 Q. I now refer you to the Hanna patent No. 1,449,226, DX 554. I now wish to call your attention particularly to page 2, beginning at line 80, which reads as follows: "We take a charging stock, therefore, with a material range of boiling points; to wit, of not less than 200 degrees F., and in the primary heating keep such stock under such a pressure as to at all times during such primary heating pre-
3786 1904 vent vaporization of any material portion of the charging stock whereby substantially all of the charging stock is at all times during such primary heating retained in liquid form and cracking thereof substantially avoided."

And referring again to page 2, line 2 to line 40 which reads as follows: "Preferably, we force the charging stock into and through the primary heating
3787 means under pressure so that a pressure in excess of the pressure maintained during the cracking operation is maintained on the charging stock during the primary heating. Vaporization of any material portion of the charging stock during primary heating is thereby prevented."

Referring again to the same patent, page 4, line 50, which reads as follows: "By thus primarily heating the charging stock we are enabled to most materially reduce the heat demand upon the heating element of the cracking system proper which, therefore, need not be greater than to supply the heat of the reaction, vaporization, refluxing and radiation losses thereby eliminating excessive cracking of portions of the oil."

In the instances that I have referred to from this patent to Hanna, Exhibit 554, does the patentee use the word "vaporation" to mean "vapor formation", "vapor liberation" or both?

A. In each case he means "vapor formation" or "generation". In the first one, page 2, line 26, vapori-
3788 zation is retarded by pressure so the oil stays
1905 in liquid form. In the second one, page 2, line 33, the pressure is maintained so that vaporization is prevented. And on page 4, line 50, the heat of vaporization is again spoken of and that heat has to

do with that required when a change of state occurs. The change of state is, of course, the vapor generation, so in each case it is vapor generation.

Q. I now refer you to the Hanna patent 1,449,227, Exhibit 555, and particularly to page 1, line 88, which reads: "this additional heat being sufficient to compensate for the loss of heat due to vaporization from the vaporizing chamber, loss due to radiation etc." Does the patentee, in this quotation, use the word "vaporization" to mean "vapor formation," "vapor liberation", or both?

A. Well, the loss of heat due to vaporization is again referring to the latent heat required for change of state; such vaporization is, of course, vapor generation.

Q. In the same patent, page 4, line 72:

"If, therefore, the temperature of the oil in the
3789 coil be allowed to rise materially beyond that of the bulk oil in the vaporizing chamber, it is evident that vaporization will occur in the coil unless provision is made to prevent this. This vaporization may be prevented by maintaining a certain predetermined pressure on the oil in the heating coil or heating zone in excess of that of the balance of the system."

Does the word "vaporization", as used by the patentee in this quotation, indicate or mean "vapor
3789 1906 formation", "vapor liberation" or both?

A. Again he speaks of pressure to prevent vaporization. Pressure, of course, will prevent vapor formation and not vapor liberation. There can be no question of which he means here.

Q. I now refer you to Hanna patent No. 1,655,603, Defendant's Exhibit 561, page 1, line 35, which reads:

"The partial pressure effect of the steam is to permit a continual vaporization of the oil at a temperature below its boiling point at the pressure employed."

Does the word "vaporization", as used by the patentee in this quoted matter, denote "vapor formation," "vapor liberation", or both?

A. Well, the partial pressure effect is, of course, related to the pressure effect and restrains or assists
3790 in this case the vaporization, and the partial pressure tends to lift it out, and that again is a matter of formation.

End of Testimony Under the Rule.

1907 *Cross-Examination by Mr. Hall.*

3790 I graduated from Massachusetts Institute of Technology, 1912, as Bachelor of Science, from the University of Geneva, Switzerland, 1916, as Doctor of Science.

I was not employed at that time.

I first found employment after my graduation by the M. I. T. as instructor in the chemical department. The first year that I was connected with M. I. T.
3791 I was, right after graduation, in the analytical chemical department as assistant to Dr. Fay; and the second year after graduation as an instructor in the freshman chemistry department.

I remained there just those two years at that time. I came back later from Geneva and spent a second year in '16 and '17 as an instructor in the freshman chemical. I was never a full professor.

Next during part of that period I made my connection with the Bureau of Mines in connection with the war work, and that continued for the rest of '17 and through '18 until the war was over.

With the Bureau of Mines I was located in Boston, with another man we had built a well equipped laboratory for research and development work, and we finally turned that over to the Chemical Warfare Service, together with our services and others that we hired, to be of assistance to the Government.

3792 The name of the other man was Louis Agassiz Shaw.

1908 I was connected with the Bureau of Mines for less than two years, perhaps a year and a half and that was not all spent in Boston. Boston was my headquarters but this laboratory increased in size as the work given to it increased so that we had perhaps 25 or 30 men, men mostly in uniform, and I was in charge of that, but I had other duties, too. I was in Cleveland, had a laboratory there, about once every week for a couple of days. And at the Gas Defense Conference at Long Island City—almost every Friday evening.

When I was with the Bureau of Mines we had a great many jobs to do. It is a long time ago. I

remember one that turned out to be very important, we had to develop a method of testing felts which
3793 were at that stage of the gas mask design and production used for filtering out smokes as contrasted with the gases, and to make a felt that was uniform and without large pores in some part of it and small pores in the other, was difficult enough, and strict control had to be carried through all stages of the production. We worked on that quite a bit.

Besides developing a method of testing felts we finally developed what the War Department called "Suck on" filter from paper pulp. That was all for gas masks. I could cover that by "gas masks." We did other things besides that. We had a long period we were working on the destruction of carbon monoxide which bothered the people in the sub-
3794 marines and that was not too successful.

1909 I worked directly under Dr. W. K. Lewis, who was in charge of gas defense at the Bureau of Mines. I don't mean to say that I think Dr. Lewis was in charge of the development of defensive gases during the war, I said gas defense.

By gas defense I mean gas masks and other things than gas masks. It is the opposite of offensive warfare or gas warfare, if you will; it is protection against it. It was officially called the gas defense division.

I do not think Dr. Lewis was a Lieutenant Colonel. He did not get into uniform.

After I got out of the Bureau of Mines, Mr. Shaw and I moved the laboratory and the contents of it to the Harvard Medical School where arrangements had been made to carry on some of the physiological work which we had run into in connection with this
3795 gas mask work, and I spent two years there. I do not know as I mentioned it before, but I would like to now, that while I was at the Medical School and carrying on the physiological work and taking courses I conducted at the same time a considerable amount of engineering and chemical work with the New Jersey Zinc Company as a side line, having to do with the dust removal systems and generally cleaning up the plant, and finally having to do with the segregation of part of their mines in Franklin, New Jer-

sey, where a certain amount of lead was found and which they had not seen or suspected which was giving them a great deal of trouble. After I got through with that work, except for the summer that I spent in Elko, Nevada, with Mr. Catlin, help-
3795 1910 ing him on the shale oil education process that he was then working on, I went then from the Medical School to the laboratories of Arthur D. Little, Incorporated at Cambridge, Mass.

3796 I was engaged on the shale oil education process just for the summer of the year, I think it was, '20. Mr. Catlin, like some of the people in that day, feared that our petroleum reserves were going to eventually be depleted and he knew the country well, he was a well known mining engineer, a very large quantity, mountains in fact of an oil shale which contains a matter of barrels per ton of oil if it could be removed economically. He developed a process and during the time when heavy oils without much gasoline content in their natural state were selling as high as a dollar a barrel, he operated that plant for about a year at a profit. When the price of crude fell and it, of course, stayed down pretty much since then he could not operate at a profit and, if I remember correctly although I am not certain of this, I think that he gave the process to the country as a whole. He was quite a patriotic citizen and in a sense—after he could not sell at a profit he gave it
3797 to the country as a second line defense in case our oil reserves were depleted. I am sure it is not operating today, and it went out of business so far as I know probably about '21 or '22. I am not certain of that date.

A partial description of the activities of the Arthur D. Little Laboratory might be that it is a sort of a free lance concern that carries on any investi-
1911 gation work for all comers including parties engaged in patent litigation. It is a group of chemists and engineers that act as consultants to some of the very important corporations of this country. Furnishing expert witnesses is a small part, perhaps. I have known of two or three or four
3798 cases where that happened, not of many. I was there at the Little Laboratory for, I think, nine years

and in six, during six of those years by far the largest part of it had to do with either the development of a cracking process that I have mentioned at Little, or with work directly connected with the Magnolia Petroleum Company. Eighty per cent of the time over those six years was spent in petroleum refining.

This cracking process I have spoken about that I developed, that was a vapor phase process. We started out with a small and not very, I will say, very easy to operate unit but changed that a number of times until at Little in Cambridge, in their back yard, we operated during the working days of the week, I don't recall its running longer than six days
3799 in the week,—a continuous tubular still where 25 barrels a day was put through. And then through a longer digester, if you will, 20 feet, in this case 6 inches in diameter tube that was heated in an electric furnace and maintained just as close as we could at 600 degrees. This was small. The one at Tiverton was larger, there were two and they were 12 inches each. I said 600 degrees Centigrade, that is 1112 Fahrenheit. It just happens we had our pyrometers reading to Centigrade and when I think of that I go back to that.

1912 We had a large insulated chamber perhaps, well it was not square, it was V in shape and that was about 18 inches on the side and those were electrically heated sections controlled outside in cross section, that was, roughly, a triangle. The tube was
3800 20 feet long. It stuck out a few inches at each end. We never put a batch of oil into the tube. It was a vaporizer, a tubular device, ahead of that some 220 feet of half inch tube through which the oil was pumped under pressure. It was vaporized and partially at least cracked in the tubular heater and the dry vapors entered this chamber, and this is where we imposed the highest temperature on the oil to effect your cracking, a few degrees, 10 or 15 higher along there than existed from the tubular heater. We had it right up at the higher temperature in the tubular heater. That 25-barrel a day unit was run there in the back yard, that was really the develop-
3801 ment plant there in Cambridge, and when we thought we were set on our process and, as I said before, not

entirely or not so much for the cracking process itself but the several processes which followed this cracking in which the gas was converted to these higher alcohols which were the primary product that we desired; then we built a larger unit at Tiverton, Rhode Island. Between 20 and 25 per cent of our oil material boiled in the gasoline range, taking 437 and point gasoline.

3802 Our clients were Blair & Company, the Barnsdall Corporation and the National Distillers, and they formed this Petroleum Chemical Corporation 1913 which built and operated these plants. Mr. DeFlorez was engaged in that work. We engaged Mr. DeFlorez as a part time consultant, and once a month for two or three days he would come up and discuss things and make various little pertinent suggestions about the construction of the furnace and its operation.

The digester tube at the end of the vaporizers had a very low pressure, I wouldn't think more than ten pounds or so, just enough to carry the vapors from there on through the apparatus. The oil was pumped under higher pressure than that, perhaps as high as 75 pounds, as I recall, 75 to 90 pounds,
3803 at the beginning of this tubular heater. Where the cracking occurred the oil itself in the beginning of the tubular heater the pressure was 90 pounds and it dropped on the way through until at the exit I don't think it was over 10 pounds. We had no gauge on there at that point. And it was about 10 pounds through the large digester tube. We just had sufficient pressure to carry the material on to overcome the friction drop in our tubes. Mr. DeFlorez was also associated with the work I did on the large plant. He didn't get to Tiverton very often, I don't think. I went down with him a few times. But that was really building again, and in larger size, the same thing that we had built in Cambridge. He was helping us mostly on the design of the furnace. That plant or that process was abandoned at Tiver-
3804 ton at the end of 1926, and as a cracking process it was not operated again, so far as I know. The chemical end of that, the treatment of the gases so produced, which we then certainly considered to be

the important part, was taken to Barnsdall, Oklahoma, where instead of using the vapors, the
1914 gases, the non-condensable gases from a vapor phase cracking operation, we took the ordinary still gases from whatever cracking equipment they were then running. I don't recall what they were then running. I think they were actually running a Dubbs process. I don't recall. That was the chemical end and I was not so closely associated with the chemical end, and when it went to Barnsdall, Oklahoma, I had little more to do with it except to keep in touch. At any rate the cracking end was abandoned in 1926.

Q. Then I think you said you spent some time
3805 in an actual oil refinery where they were producing gasoline commercially, is that correct?

A. During the three years that the Arthur Little Company acted as the consulting engineers and chemists for the Magnolia Petroleum I made many trips to Beaumont, Texas, spending a week or two at a time. In fact I perhaps made a trip about every two months during those three years.

My duties in connection with that work were numerous. They had to do with a survey of some of their operations, their crude distillation first of all. I recall we tried to interest them in better fractionation at that time, but no changes were made until some years later. They were interested in looking over the field of cracking plants that were available and we investigated to a certain degree the Dubbs process and Holmes-Manley and tube and tank, and of course they had the Cross units there. We were interested in improving their lubricating stocks.
3806 1915 That was simple distillation, fractional distillation and cracking was definitely thought to be avoided by having the temperature low as possible but having a very low pressure on the stock so that vaporization would be facilitated. As to the work which I did in connection with their cracking operation, they had the Burton units which they had operated for years and which continued to operate, if I remember correctly, until as late as 1929, and they seemed to be entirely satisfactory. There was nothing that we did about that except to note the

operation. I don't recall that they particularly told me they were satisfactory to them. I know only that they continued to run them after they had quite a row of Cross units in place and up until as late as 1929. They used clean gas oil, the lighter end of the gas oil as charging stock for the Burton stills,
3807 "selected" gas oil stock is a good description. I am sure those stills have all been abandoned. I was down there recently to check up.

In connection with that plant I referred to certain coking stills. I will describe these particular stills. They were shells, horizontal cylinders, that held just under 1000 barrels of oil when they were charged, and they had very little refluxing equipment and nothing that I would be willing to call really fractionating equipment in those stills. They did have an aerial condenser, one of these things up in the air, so a small amount of air partial condensing occurred, so that for example when the gasoline was being distilled over, some of the kerosene that tended to go with it would tend to go back. However,
1916 their separation was not very good. They heated these stills with gas. They were at the
3808 end of a high pressure line that came down from North Texas and they had a good market for their fuel oil, so they sold their oils and used the gas, which they couldn't sell. The cycle on these—I will call them 1,000 barrel stills, although they were perhaps 30 or 40 barrels less than that—was 36 hours.

They would get the body of oil up to temperature and onstream and make their several cuts, gasoline and kerosene and gas oil, and their lubricating—That was all atmospheric pressure. Just what you would call simple distillation. The charge was the crude, just as it came out of the ground, and it was not always the same. In each of these, as I recall, 120 coke stills which were there in a row, some of them were used to make lubricating oils, and some weren't, and some weren't carried down to coke. Some were carried down to residuum so that they could make the bright stocks and other heavy lubricating oils which they didn't distill over. By residue I mean
3809 the residue left behind from such an atmospheric distillation of the crude.

Q. Left behind after what cut had been taken out?

A. Well, it depends upon what your operation is. If you were making—

Q. I mean these operations that you said were carried on at this Magnolia plant.

A. Well, I was referring at that particular minute to a particular operation where the residuum left behind was subjected to very strong acid
3809 1917 treatment to convert it into a bright stock, the heaviest constituent of the lubricating oils that were made in those days, in which case they would pick a clean crude that had not too much asphaltic and tarry materials and would distill off the gasoline, kerosene, gas oils and the light lubricating oils and then stop. That might leave 30 or 35 per cent.
3810 That is what is ordinarily known as a coking still. It was taken down to coke. A shell still in which the crude oil is taken down to coke is ordinarily known as a coking still, so far as I know.

Q. In a coking still operation, ordinarily, don't they take the lighter material off in some sort of a fractionating equipment and then just run the very heaviest material in a coking still down to coke?

A. That would be a good idea, but they weren't doing that in Beaumont. I was describing the operation you asked me to describe. They didn't do that. They put the crude oil in with the gasoline right present as it came from the ground. As I de-
3811 scribe it, it was nothing more than an ordinary simple fractionating equipment without very good fractionating equipment attached thereto. It was a method of separating the crude into the constituents, which we rather roughly called gasoline, kerosene, gas oil and the like.

Q. Did you just have one take-off line from the shell still?

A. The line went to this overhead aerial condenser, and that was used in the early part of the
3811 1918 distillation, but there was a bypass of it when the distillation had reached a point where the lubricating stocks were coming over because they didn't want to overcrack the heavier materials in the still, and they just took them as fast as they could away and condensed them. If they refluxed back they would have had cracking, and that would

have harmed some of the lubricating stocks. To separate the various fractions from one another as soon as the gravity of the stream changed from one
3812 predetermined point to another the operator just shifted the valves and put it into another tank. I don't think that still had a dome on it. At least I don't recall any large dome sticking up there. I have seen that type of still provided with domes from which the vapors lead off. There may have been one there. I just don't recall.

They had some Cross units at that plant. Describing the operation which was carried out in the Cross units, they consisted of a furnace and a tubular heater through which a clean charge, distilled gas oil, was pumped at a fairly high pressure. If I remember rightly they used at that time 600 pounds. All of the heat was put in the oil in this tubular heater, and then there was a long horizontal and very thick reaction chamber. I haven't seen the figures for a long time, but I should think it was 50 feet or more long and
3813 a matter of inches thick.

At the Beaumont plant the first two that were installed the vapors were taken from that reaction chamber at the opposite end that the oil that came from the heating tubes entered the chamber,
3813 1919 and were taken out in a horizontal pipe coming out of the end of this long thing that looked like a cannon but from the top of it, near one end. I state that because I recall I have heard it stated that at early dates they took the mixed vapors and liquids out of the end of the chamber. At Beaumont the intent was, and I believe it was carried through, that vapors were taken from the top of that chamber. They were used first to keep hot the bottom of the fractionating tower in case the materials condensing in it contained too many light products, and these hot vapors from the cracking drum went through a heat exchanger located within the bottom of the fractionating tower—they were not directly in contact with them—and then off to, I don't know what you call it, a tar separator of some kind, where the heavy fuel oil was withdrawn, and then the clean vapors from the top of that residuum separator
3814 entered the fractionating tower and passed up through it.

Cooling, of course, was introduced at the top of the tower to condense everything except the gasoline which went overhead to the final condenser, and the clean reflux within the tower descended to the bottom and then out to a cooler where the heat was just extracted. I don't recall for the minute whether that was a heat exchanger or whether the heat was discarded. I won't guess. I don't know. It went to a tank where it was stored, and then that, plus fresh gas oil, was the charges for the next day's or next week's or some other time run. In other words, 1920 they didn't recycle that hot reflux back to the
3814 heating tubes at that time, that was either 1925 or 1926. I think we will say 1926.

Giving you my definition of the word, I think
3815 residue might be the thing left behind.

Relating it to a petroleum refining apparatus, either cracking or simple distillation, in a simple distillation of a crude oil, for example, as it comes from the ground, containing all of the components of the crude, which normally would include a certain amount of asphaltic materials, if you will let me use that as a class to represent that group, then the distillation might be conducted to separate fractions all the way down the line so that only this residual material is left behind. Then I call that residue. At any stage after I have taken off the vapors that form any fraction I would consider what was left behind in the still a residue.

Q. Now, you referred on your direct examination to the operation of pipe stills in California. Did you ever see such a still in use in California, and if so, will you please state when and where?

3816 A. Mr. Hall, I can't answer that and be certain. I made several trips to California. I think I better say no. I don't think I can recall a pipe still I saw operating like that in California.

Referring to Defendant's Exhibit 778, I thought that I said in my direct, Mr. Hall, that the furnace was taken out of the Wadsworth Bulletin. We put the furnace in perspective that was shown in that Bulletin as having been built as early as 1912.
3816 1921 We chose that one simply because it was old and could not be classed as modern, and we

didn't think we were going to start anything when we put it on a piece of paper.

3817 The Witness: It is on page 49 of this Wadsworth Bulletin, and instead of showing it as a side elevation and an end elevation, as is shown on 49, we did our best to represent it on that drawing, Defendant's Exhibit 778, as an isometric drawing, so that we can more easily follow it. We copied the exact arrangement of tubes just as closely as we could.

Again referring to Defendant's Exhibit 778, the valve C will perform no purpose in an atmospheric distillation operation. It would be open, of course, to permit distillation to occur at atmospheric pressure.

Q. In a cracking operation what function would it perform?

3818 A. Well, it could be used in a vapor phase cracking operation to maintain the vapors being cracked in the coils under pressure. The pressure might be such and the temperature such that vaporization would occur and the cracking might be largely in the vapor phase, but the time factor would be increased by maintaining the pressure on the coils.

When I referred to the dehydration of petroleum, I had in mind the dehydration of emulsified oils. I have never seen that performed commercially. I have had occasion to use it myself on small quantities, and use it over and over and over, and had it work out very nicely, however.

3818 1922 I have never seen a commercial operation carried on for the purpose of producing kerosene as a primary product of a cracking operation. I have,

3819 of course, as secondary products. When I refer to a secondary product I mean an inevitable product that couldn't be avoided in a cracking operation, the primary product being gasoline.

I wonder if I said the Atwood patent No. 28,448 disclosed a continuous cracking process. I don't remember. It most certainly isn't. It is a batch process. The Merrill is also a batch process. In other words,

3820 both Atwood and Merrill are of the Burton type in that they are both batch processes and not continuous processes. I have never seen in operation in any place, commercially, a setup such as is shown in the Dewar and Redwood patent No. 419,931.

I heard part of Mr. Behimer's testimony in this case in reference to his struggles to overcome the infirmities of this patent or this process in his effort to produce a process for cracking to produce, primarily, gasoline. I was not present during the entire period of that testimony.

3821 I believe that the process disclosed in this Dewar and Redwood patent is an appropriate process for making kerosene, primarily, and except—yes, I think that that process just as it stands could be used at a somewhat higher pressure and temperature than it was used by Dewar and Redwood to make kerosene, to make gasoline. I don't know why not.

3821 1923 Q. Do you think you could achieve success in making gasoline on anything like a commerical basis following the teachings of the Dewar and Redwood patent?

A. In 1890 I wouldn't be surprised, Mr. Hall, if the small yield that such a still as that might have produced in a day might be commercial.

3821 1924 Q. Well, I am speaking of, we will say, the year 1916, when Mr. Behimer entered the field and, as you heard him testify, tried out his scheme and discarded it. Do you think, notwithstanding that, that you have sufficient ingenuity so that you could have used it successfully for making gasoline in 3822. 1916?

A. I just glanced through this patent again to see if I could see anything about volume. It doesn't state that and I suppose I am not to be limited to some very small volume in looking at it.

Q. Oh, no. You look at it just like Mr. Behimer looked at it when he was endeavoring, on behalf of The Texas Company, to produce a cracking process for making gasoline which would compete with Burton, and failed, in connection with Dewar and Redwood. Do you think you could have done it?

A. Well, I can't do just what you said because I didn't hear Mr. Behimer make just that statement.

3823 The Court: Well, leave that out and ask him if he could produce gasoline on a commercial scale.

Mr. Hall: Q. If you had been desirous in 1916 and 1917 of producing gasoline on a commercial scale which, we will say, would compete with the Burton process, do you think you would have found all the

information you needed for that purpose in the disclosure in the Dewar and Redwood patent?

A. I must say I don't see quite where this is heading, but I think I would, Mr. Hall.

3823 1925 Dewar and Redwood teaches the introduction into the shell still as an extraneous pressure medium either air or any inert gas, he says, which will not react on the oil. One of the mediums he suggests is air.

Now, if one should introduce air into a pressure still used for making gasoline and operated it with air
3824 in it I don't think the still would blow up, The explosive limits of hydrocarbon vapors and air are relatively narrow. I feel pretty certain this would be too rich a mixture to so explode. In Dewar and Redwood there is a shell still used to hold the oil undergoing cracking. Except for the end of that shell still which projects beyond the furnace setting the furnace gases play all around that shell.

In a shell still operation at a high temperature to have your furnace gases play at a point above the liquid level in the shell might create some trouble. Right at the liquid level line, if your furnace gases are playing on the shell still at that point there would tend to be a rapid accumulation of carbon there.
3825 That might soon cause hot spots. Most of these early shell pressure stills had that difficulty. I don't think it would be fatal at all in a shell still to have your furnace gases play above the liquid level. I will put it this way, I never would build one that way. I never have built one that way.

Q. Well, do you know whether that would be considered fatal to man actually engaged in the industry who do build stills to make gasoline?

3825 1926 A. To make gasoline, I never saw a still so set. I wouldn't think it would be good engineering practice. I wouldn't expect to see one so set.

Q. Well, I am only asking about one thing now, heating the still above the liquid level do you or do you not know whether that is a fatal infirmity in shell still practice when you are using a process for making gasoline?

3826 A. I never heard of its being used in a commercial still. I wouldn't so use it. I don't know as I ever heard it was fatal either.

Q. Now will you kindly answer the question?

A. As the question was asked, the answer is, definitely, yes, it would be fatal, because Mr. Hall's question concerns heating it only above the liquid line.

3827 Q. Do you know whether or not in a process for making gasoline, primarily, using the temperatures and the pressures which were used in shall still practice when that was done, whether an arrangement and a procedure such as is set forth in the Dewar and 3828 Redwood patent, which indicates that the shell still is heated at and contiguous to the liquid level of the liquid in the shell still, do you know whether or not that would be fatal?

A. I don't want to say yes or no until I am certain what "fatal" means, but if you mean would that be fatal to the extent of greatly shortening the run, making it a less valuable process, I would agree with you; I don't know that I would get a noncommercial process.

I don't think I have seen the exemplification of 3828 1927 any of these patents that I referred to on my direct testimony and excluding only Burton and 3829 Burton-Clark as a commercial operating process I recall that Trumble states in his patent that it has been used commercially, but I don't know that of my own knowledge. I don't know of my own knowledge that these patents except Burton and Burton-Clark have been used commercially.

Referring again to the Dewar and Redwood patent No. 419,931, this discloses a shell still C, the feed of the oil through a pipe E' into the shell near its closed end and the withdrawal of residue through the pipe E2.

Q. Now, do you know whether or not the liquid oil in this shell still throughout would be of substantially the same composition?

A. Do you mean throughout a given batch run?

Q. No, in any particular period. That is, I mean end to end, contrary to the teaching of Dewar and Redwood that he would feed fresh oil into the closed end and draw off residue at the other end which would be of a radically different composition from the oil near the closed end. Now, as a matter of fact wouldn't it all be substantially the same composition?

3830 A. Can you show me where that is in the patent?

Q. In the patent, (indicating), it feeds into this right near that end?

A. Yes.

Q. You have just said he withdraws residue here, haven't you?

A. Yes, but I—

Q. All right. Now, is this oil all of substan-

3830 1928 tially the same composition?

A. If you are suggesting that the Dewar and Redwood is a continuous process with the feed being put in while the thing is in operation and residue being drawn off continuously, I wish you would show me in the patent where that occurs. I think I must have missed it. At least I didn't find that it so operates when I examined this patent. I don't think it

3831 operates that way. Wait a minute, and I will find out. He says on the second page, in line 18:

"E is a pump for forcing the oil to be treated by a pipe E' into the retort C, this pipe preferably extending nearly to the farther end of the retort. By another pipe E2, furnished with a cock or valve, the contents of the retort can be drawn off, or this pipe may communicate with a second retort, which in like manner may be connected with a third, so as to form a series of any required number."

I didn't read that and understand that it meant it was continuously allowed to enter and continuously withdrawn. I took this to be a batch operation in which oil was put in and cooked for a period and then the residue was withdrawn.

Q. What do you think is the purpose in feeding the oil through the line E' and discharging it near the closed end of the still? If it is a purely batch operation why wouldn't the same effect be obtained without the part of the pipe which extends lengthwise of the still?

A. Well, that pipe going down to the back end of the still might make possible such an operation,

3831 1929 but until this minute I had not considered such operation as being taught by Dewar and Red-

3832 wood. He doesn't specifically cover that, as far as I can see.

Q. Well, whether that is the operation or not,

would the oil in the shell still be substantially of the same composition throughout?

A. Assuming that there was no circulatory step such as we have been discussing but that it was a batch operation, then there would be a difference in composition in the oil contained in the still. The part extending out beyond the furnace setting would contain more than its share of the condensed recycle or reflux which is produced in cooling in the dome C. It would fall directly down at that point.

On page 2, line 65, he states that "If necessary, means of cooling may be applied to the still-head C2," for the purpose, of course, of producing the reflux. On that basis the composition of that part of the still outside the setting would be lighter in gravity than that in the inside.

If there were circulation going on, if fresh charge
3833 were being fed through E', through that long pipe to the far side, the back end of the still, that would be fresher stock that that in the front end of the still, and the residuum content would be less in the back end of the still under that condition. So that in either case, according to my representations, you would not have uniform composition throughout of the liquid in the shell. I am sure I would have most of the reflux in the end of the shell which projects beyond the furnace setting, that is the point of
3833 1930 the shell or the part of the shell from which the drawoff line E2 leads; so it would follow that the material that you would draw off, if you had anything in the nature of a continuous drawoff, a continuous operation of this still with the devices as shown would carry out of your shell the part of the oil which contained the larger proportion of reflux.
3834 I would think that this Dewar and Redwood setup would exhibit at least all of the infirmities that were exhibited in the operation of a Burton still, in reference particularly to the baneful effect of carbon accumulation on the heating surfaces. Of course there would be this difference: Dewar and Redwood teach the lower intensity of cracking in making their kerosene than Burton taught in his gasoline operation, but that difference would be a matter of degree.

Q. Well, I think that is a difference we would not be concerned with because we are not concerned in

this case with the manufacture of kerosene. It is what that process will do when you want to make gasoline, and with that understanding you would say it would have exhibited the same infirmities, would you not?

A. Used for the same purpose, it would.

I am not familiar with the fact that the Tidewater
3835 Oil Company tried out the scheme of the Edwards patent No. 1,170,084 and abandoned it. I have no information on that line. And I have no information of the use of the process of the Edwards patent at any place or at any time.

In the scheme of Edwards I would say the setup shown in Fig. 5 is typical of the apparatus. As there shown in Fig. 5 the apparatus includes two
3836 1931 horizontal drums 8 and 10, each being provided with spaced apart partitions which are designated, respectively, 9 and 11, and each partition is provided with a large hole in its bottom, or opening, which is designated 18 in Fig. 3, as to the partition in drum 8, and 19 as to the partition in drum 10, which permit the residue or permit the oil in one compartment to run into the adjacent compartment. Referring again to Fig. 5 and to the drum 8, the compartment at the left is the first compartment and the oil runs from there into the adjacent compartment and then on into the third compartment, and then on into the fourth compartment, where it is, or a part of it is, withdrawn. If by liberation we both mean the bulks separation or movement off to another vessel, I will agree that the vapors that are generated by the passage of the oil through the heaters 1, liberate themselves from the oil in these several compartments and pass up through the vapor space in the upper part of the drum 8, and then outward and up to the condensing mechanism, which includes a partial condenser and a final condenser.

3837 Q. Well, by liberation I mean the vapors which have been generated in the oil pass from the oil in the drum 8 up into the part of drum 8 which is above the level of oil in drum 8. Do you agree with that?

A. That "passing from" covers it very nicely, yes.

That leaves behind in each of these compartments which are formed by the end walls of the drum 8 and

the partitions degraded oil. In other words, it leaves in each of those compartments formed as I have last stated a residue. That residue returns to the heating coils through the line 15, and it also returns to the heating coils through the line 17, drum 10 and line 16.

3838 1932 So that as I stated in my direct you have in this patent a scheme in which there is circulated round and round in all of the heating tubes a combined feed consisting of fresh oil and reflux plus a residue. In other words, we cycle round and round through the heating tubes this residue mixed with the reflux and the fresh feed in this Edwards scheme; and all of the fresh feed and the reflux enters the first compartment in the drum 10; that passes up and then we have a cycle from that first compartment in drum 10 through the first compartment in the drum 8, which
3839 includes the heating tubes, and in that cycle we have the combined feed and the residue. Now, between the second compartment in the drum 10 and the second compartment in the drum 8 we have a light circulation of oil round and round; all of that oil that then circulates round and round has been degraded, or contains residue; and that is true of the third and fourth compartments.

3868 1933 I am familiar with the commercial cracking apparatus in which they use a pipe heater or coil discharging into a digester or vapor separating chamber, the vapors going out overhead to an overhead condensing mechanism, including a partial condenser, and the partial condensate being returned to the entrance end of the pipe heater.

3869 Referring to the Ellis patent No. 1,396,999, I do not consider the part which is marked "Digester", that is the tube 8 to correspond to the vapor separating chamber in such commercial apparatus. It is correct that in these vapor separating chambers of the commercial apparatus to which you last called my attention there is a residue drawoff from the bottom of the chamber. In Ellis there is no equivalent to that in the digester. The only equivalent to that would be at the bottom of the fractionating tower, the lower part of which collects the heavier residue, and it would be withdrawn at the cock shown at 11. I concede that this Ellis patent does not specifically say to

return the condensate from a partial condenser back to the entrance end of the cracking coil as a continuous operation, and with its contained heat. The
3870 process of this patent is a vapor phase catalytic one. He mentions catalytic effect with respect to two parts of his apparatus, the treatment after the desired product, gasoline, is made in the vapor stage in what he calls a hydrogenator, and he suggests the optional use of a catalyst in his cracking tubes as well. Where the patent says the decomposing tubes I took that to mean the small tubes at the bottom of the fur-
3871 1934 nace rather than the large digester, these small tubes in figure 3 are marked 4a, 4b, 4c and 4. He says that he places in those tubes a catalytic material preferably or optionally. He says, on page 1, line 57: "In the decomposing tubes I preferably place catalytic material." But he makes a definite statement about the fact that if catalytic material is used, nevertheless it permits the ready flow of the vapors.

Q. Would it be your understanding that in this patent these tubes, except for the catalytic material, are filled with vapors?

A. Well, he teaches charging an oil, so for a certain distance through those tubes there would be oil
3872 and then vapors. As to the oil which is charged to the system, he teaches the use of a light clean distillate and seems to prefer kerosene. He states on line 11 of the first page, "Making gasoline from heavier oils such as kerosene and the like." That would indicate a relatively light and clean distillate stock. As to the oil temperature he uses, line 44 on page 1, states "400-600 degrees C." That is 752 Fahrenheit to 1112 Fahrenheit. Just a moment. He says:

"This element may consist of a series of tubes placed in a furnace and adapted to be heated to a temperature of 400-600 degrees C."

That isn't too specific, as to whether he means the tubes are to be heated to that temperature or whether the oils. I will give you the high vapor phase
3873 1935 cracking temperature in a minute. Hall, for instance, measured the temperature within the nest of tubes in the furnace. This man states that the series of tubes are placed in a furnace and adapted to be heated to a temperature of 400 to 600 degrees

Centigrade. The difference in the temperature of the tubes and the contents might be 40 or 50 degrees, or something like that. I don't think the patent (Ellis) is uncertain as to the oil temperature. He gives a wide range there somewhere between 752 and 1112 to be the temperature which I think reads most exactly on the tubes, and I would consider the oil temperature would be 50 degrees below that. If I do the very
3874 simple thing that I just suggested and subtract 50 degrees, the oil temperatures would be 702 and 1062° F. As to the pressure under which the system operates, he makes a statement on page 4 which I will read:

"The apparatus is preferably run at a slight pressure although a considerable pressure, as several atmospheres may be employed if desired."

By "slight pressure" I would understand something above atmospheric. He probably wouldn't even have mentioned a pound or two. I think his low range might be 20 or 30 pounds and his high range—he says several atmospheres—might be 100 pounds. Whether or not the oil before it starts to crack has all been
3875 converted to vapor will depend on the oil and on the conditions, temperature and pressure and what not, because if we get above 700 degrees while there
3875 1936 is still oil present there will be some cracking in the oil, but I will certainly say that this patent teaches carrying out the bulk of the cracking after it is vaporized and in the vapor phase. I don't think Mr. Ellis' patent discloses carrying out some of the cracking, that is some substantial part of the cracking, while some of the oil is in liquid form. He doesn't state whether that is his contemplated operation or not.

Q. And you are unable to give us any information on that point?

A. I have given you information on that point.

Q. Well, I want you to give it directly. Do you say that within the purview of this patent active cracking would occur while some of the oil is still in the liquid phase?

3876 1937 A. Since the minimum temperature indicated in this patent, even with the 50 degrees off that I have suggested, is about 700 degrees, definitely in the cracking range, and since the pressure may be

upon the oil, there could be and doubtless would be some oil existing at 700 degrees, and some cracking would occur in the oil, therefore.

Q. Well, don't you know that it is impossible to successfully carry out vapor phase cracking where some of the material undergoing active cracking is in liquid phase or in liquid form? Don't you know that?

A. You specifically asked if you can do vapor phase cracking when it is in liquid form. My definition of vapor phase cracking is when it is in vapor form, but I don't know how to get oil under some conditions, and these conditions are indicated in this patent, into a vapor phase so that it can be cracked vapor phase without doing some cracking in the liquid phase first.

If we have a stock that would all be vaporized before we reached cracking temperature, then we would
3877 have dry vapors which would be heated to a cracking temperature.

Q. Now, isn't that the characteristic of the present day successful vapor phase cracking processes for making gasoline?

A. Well, I am not, perhaps, familiar with all of them, but I know of some that would run on that principle where a kerosene-like stock is heated at a fairly high temperature and at not too great a pressure.

3878 1938 I don't know of any vapor phase cracking processes for producing gasoline that are in commercial use today where that characteristic is exhibited that the oil is vaporized before it is cracked. I am not familiar with all of them as I said before.
3879 I am not familiar in detail with the outstanding vapor phase processes, Gyro. I never had occasion to investigate the Gyro process or see it run. I have heard of that process as a name and as to its industrial use. I read the literature. I have run across descriptions of the Gyro process. I said I was familiar with it. I have seen such things in the literature but I have not studied them in detail.

Q. You don't know about this characteristic as to the Gyro process?

A. I couldn't say of my present knowledge as to

whether that was so or not. I could give it some study and know shortly, but I don't know as of this minute.

3880 The function performed by this so-called digester in the Ellis patent is to increase the time factor at which these vapors are at the cracking temperature. There would be cracking there. If there were cracking there would be very high boiling material formed as a result of that cracking. That always occurs. I don't think that would deposit itself in the digester. Possibly to a very slight degree on the side walls, as a dry powder, but I don't believe there would be anything depositing in that Ellis digester.

Q. But you don't know?

A. Well, I can go back to my experience.

3880 1939 I saw such a setup as this used. I told you that I have used one very similar to it.

Q. Where you had a furnace and these cracking tubes discharging into a digester in the furnace, and

3881 with the furnace gases playing around the wall of the digester?

A. In one case the furnace gases played around two-thirds of the length of the digester, and in the other case the digester was electrically heated and maintained at approximately the temperature of the transfer line.

Q. But it was not contained in a furnace as in Ellis?

A. The Tiverton process that I mentioned yesterday was so contained, and the gases, after heating the tubular—the small tubes—circulated around the digester to prevent its losing heat. The size of those small heating tubes was one inch in diameter. The large tube in which they discharged was twelve inches in diameter; it was heated around for twenty feet of its thirty-foot total length. The charging stock

3882 in that operation was gas oil that varied between 32 and 35 gravity. The whole apparatus was not kept under substantial pressure. At the outlet there was practically no pressure, just enough to overcome the friction drop. That is the apparatus that Mr. DeFlorez was connected with. At the transfer line between the small tubes and the digester the temperature was a little under, perhaps 15 or 20 degrees, under 600 degrees Centigrade, and in the di-

gester tube was held constant between 600 and 610°
3883 C. and that is all around 1100 Fahrenheit. I still go back to Centigrade in that particular work be-
3883 1940 cause we dealt with it all the time. The length of the one-inch tubes will have to be recollection. I haven't consulted a blueprint of that for some time. If you will just let me figure a minute, I am sure there wouldn't be—the total length of the one-inch tubes wouldn't be less than 300 feet and might have been another 50 or 75 beyond that.

Q. At what point in that length would you say the cracking commenced?

A. Well, I recall that the furnace was divided by a bridge wall and that the first section of that tubular heater was called a vaporizing section. I can see too that the bridge wall was somewhere near the middle
3884 of those tubes. I don't know that that proves it or not. I never made an examination to determine where it actually was vaporized.

Q. Now, you speak about the first section. Was there more than one section in this tubular structure?

A. There was a bridge wall dividing it. The cracking section was contacted with the products of combustion first and then the vaporizing section was behind the bridge wall.

I mean the cracking section of the tubes received the highest heat; beyond that we had a vaporizing section.

Q. How long was the vaporizing section?

A. I have included it all and said that that bridge wall was somewhere near the middle of it. You would be safe in considering it in the middle.

3884 1941 The function performed by the vaporizing section was to convert the gas oil into vapors. It
3885 was to vaporize the oil so that most of the cracking, of course, occurred after the oil was in the vapor stage. We considered this a vapor phase cracking operation. The oil flowed first through the vaporizing section at a relatively low temperature, and then after it had been vaporized the vapors flowed through the cracking section. I imagine the oil stream and the vapor stream gradually increased in temperature all through that furnace and left it at just under the 1100 degree Fahrenheit point.

Q. Do you know whether before that oil, either in

liquid or vapor form, reached an active cracking temperature or substantial cracking temperature, vaporization had been completed of the oil?

A. Well, I certainly never made any such measurement, and I couldn't see, of course, through those tubes, and I wasn't really much interested in that.

3886 It did not seem to us of moment. I don't know.

Q. Will you please now refer to the Hall patent 1,175,910. At the top of page 2 of this patent, the first column, there is reference made to producing an endothermic chemical reaction between the gases and vapors, by compressing the same, under substantially adiabatic conditions.

Q. I find the patent states, commencing line 16:

3886 1942 "I use the term 'adiabatic' in this specification in the same sense in which said term is defined in Hasting and Beach's General Physics, (published, Boston, 1899) in which it is stated that 'a body is said to undergo an adiabatic change when its condition is altered, without its gaining or losing heat to other bodies.'"

3887 Now, do you agree with this definition given by your fellow Bostonians?

A. I think that is correct, sir.

3888 Q. In your testimony at page 3517 you said, I believe, that the oil is pretty much completely vaporized either in the vaporizer or the first cracking tubes and most cracking done after vaporization in the vapor state.

A. That is a correct extract of what I said.

I don't recall that Hall specifically says that one must convert all the oil to vapor before cracking be-

3889 gins. He is more specific than I thought. I think I read that, too, yesterday, on page 2, line 96:

"From coil 4 the gases and the cracked oil in the state of vapor—"

I am sorry, that is the end of the cracking coil, that does not answer it.

Q. That is all right. That is what I wanted.

A. Well, it says that they leave the cracking

3889 1943 coil in the state of vapor but I don't know that that says they are cracked entirely in the vapor state.

Q. And are you unable to state from your reading

of this patent whether one carrying out its teachings would convert all the oil to vapor form before reaching the point where active cracking begins?

A. You are asking me really if there is going to be any cracking whatsoever in the liquid again.

Q. No, I prefer to read the question to you—to have the question read to you.

(Question read.)

3890 A. Well, active cracking, you mean more than some incipient cracking?

Q. Oh, yes, I mean some degree of substantial cracking.

A. Well, I don't think we need to disagree then, because the main cracking certainly occurs here after vaporization in the vapor phase.

Q. But would you say under the teachings of this patent some substantial cracking might occur when the oil is in a state of vapor and liquid oil?

A. Of course, Hall gives a pretty wide choice in charging stocks and a fairly wide choice in temperatures and I hadn't thought of Hall as a cracking process for prducing considerable cracking in the liquid state, but I should think you could stay within his teachings and obtain a good bit of cracking

3890 1944 in the liquid state using the heavier oil and keeping the temperature down a bit.

A. I find that the patent states, page 2, commencing line 113,

"Carbon is thrown out in large quantities by the expansion of the gases and collects on the filling material in this and the succeeding dephlegmator."

3891 If that actually occurred, would you have carbon-containing residue flowing downward through the pipes 12 and 15?

A. I don't think that follows, Mr. Hall.

Q. You think the carbon would simply adhere to that filling and not be washed down with the distillate, heavy distillate, the distillate which flows through pipes 12 and 15?

A. You say both of them at once. You are particularly interested in 15, I think, the second dephlegmator.

Q. Well, I am interested in both of them. If there is any distinction, you can make it.

A. Well, first of all I thought I made my position clear.

Q. Yes, you made your position clear and I understood your position to be that you did not agree with what Mr. Hall here says.

A. Oh, I don't think that I said I did not agree.

Q. Then you do agree with what Hall says in the part that I have last quoted from his specification?

3892 A. In that, from 113 and a few lines on where carbon is in both, I said there doubtless wuld have been carbon in both but I did not say the same amount would be in both, and I was not ready to say by a long shot that

3892 1945 if there were some in the second dephlegmator that it would do harm to the condensed liquid withdrawn from the bottom. In this quotation that you gave me it says that carbon in large quantities is thrown out. In these two columns which are designed 9 and 14; I agree that carbon is thrown out. I don't know what he means by large quantities, I don't know what his distribution between the two is. Neither of those things is stated in the patent. He doesn't teach us what he means by large quantities.

Q. Do you know of the operation of any vapor phase cracking process which has ever been a commercial success in which in the charge there was in-

3893 cluded a residue-like material containing carbon in large quantities? Now I am considering in that connection the material which is separated from the vapors in these two chambers, that is the heavier part that flows out through lines 12 and 15 to be the residue, you would call that a residue, wouldn't you?

A. Well, you are putting them both again in the same breath, grouping them together. I consider them very, very different.

Q. All right, but they both would be residue?

A. Hall calls one a heavy residue and one a light residue.

Q. All right. Do you know of any commercial cracking process in which the charge contains a substantial portion of carbon-containing residue?

3893 1946 A. Well, please, by "carbon" you are not referring to the chemically combined carbon, you mean molecular carbon substance.

Q. Yes, such as you would get if carbon were

3894 thrown out in large quantities such as stated in this Hall patent?

A. Wait a minute, Hall doesn't state it is thrown out in the liquid withdrawn.

Q. No.

A. He says it is thrown out on the filling.

Q. He says it is thrown out and would probably be caught by the filling, but I think we will be able to show that, as we say, whether you agree with it or not, that material, the liquid material passing down through these columns and over these particles would take some of this material out with it; so I am now asking you if you know, quite aside from that, I am asking you if you know of any commercial vapor phase cracking process where residue containing carbon is used as a part of the charge?

A. Before I answer it, Mr. Hall, I want to clear up one thing. You are speaking of carbon and the word "carbon" is used in the 113th line, page 2, that you have recently quoted; and do you consider, because I do not, that he means that that is just plain carbon or the chemical symbol C so represented?

3895 Q. Well, it is carbon, carbonaceous material as they call it, it may be asphaltene—like products that is hardened somewhat but not enough to be as hard as coal.

A. All right. Then I want to just be sure you are asking me first if I know of a commercial vapor

3895 1947 phase operation which was successful and to which was charged a material containing carbon, including asphaltic residues.

Q. Yes, for making gasoline primarily now.

A. No, I don't know of a vapor phase process that was successful in which the charge was contaminated by more than the smallest incidental amount of such carbon or high carbon containing materials.

Q. Now tell us what commercial process you know of, vapor phase process for making gasoline primarily, that was successful where the charge did contain this small amount that you inferred in your last answer of residue having some carbon content, or carbonaceous material in it, or what we have sometimes referred to as asphaltenes?

3896 A. I have found it difficult to obtain commercially,

gas oil stocks in that class of distillate charge for such processes that were not considerably darkened by the presence of these small amounts, and I think perhaps this is reasoning a bit by analogy, but people that charged gas oil to vapor phase cracking processes certainly did not have water white gas oil, they had the reddish and deep yellow gas oils of commerce, that are familiar in all oil refineries and that certainly contained these small amounts of residuum that I have been mentioning.

Q. Did you ever consider the testimony of Mr. DeFlorez which was given in this case?

A. Yes, I read it and was quite interested in it.

Q. Did you recall that he said that in his operation of the Hall process or his attempt to operate it,

3896 1948 that the heating tubes were immediately coked up if he tried to rerun the material which was taken out of these tubes 12 and 15?

A. I did not understand his testimony that way.

3897 He is not talking about this patent.

Q. Referring to the Hall patent you will find that on page 2, column 2, line 113, he refers to a temperature of 325 degrees Centigrade, and at line 3 from the bottom of the same column he refers to a temperature of 180 degrees C. Where do you say these temperatures would be measured?

A. Well, that lowest one, the 180 degrees three lines from the bottom, that would indicate from the context that somewhere near that temperature was to be the tail end of the overhead material, so I should think that might mean the top of the second dephlegmator. The other one is not quite as clear.

3898 If I were reading only the part at lines 112 and 113 I might feel that was near the bottom of the first dephlegmator, but I think the other refers to that same temperature. At line 119 more definitely indicates the top of the first dephlegmator; and also referring to the drawings I noted a moment ago that what looks to be a thermometer appears sticking out of the top of the vapor line leading away, I should think possibly that I would conclude that it was at the top.

In the operation of the Burton still with which I was familiar I never made any measurement of the ratio of the reflux to the gasoline produced or the

pressure distillate produced in the operation. I
3899 1949 never discussed such a thing with the people at the refinery. I do not know that they were interested in it, either. I don't know who knew that at Beaumont; certainly I never learned it from them and I don't know it now. I do not know anything by my own measurements about, even roughly, the amount of reflux which is produced in these pressure stills for cracking to produce gasoline primarily in reference to either the feed or the gasoline produced, or the pressure distillate which is produced; but I have had an understanding for a long time that the reflux ratio to the fresh feed in such a process, might be two or three or even more times to one. In other words, in all of these so-called pressure processes that are in use commercially for making gasoline by cracking, the reflux is quite substantial in amount as far as I know.

Q. Now referring to the Smith patent 1,239,423, what would you say is the amount of reflux which is produced in that operation, either as to the gasoline
3900 or pressure distillate or fresh feed?

A. Well, of course, there is no very satisfactory dephlegmating device shown or disclosed in that patent, Mr. Hall. I can not even tell for sure that the top of the still is entirely outside of the setting, so that it would be cold enough to produce some. I would say the reflux ratio in this particular patent of Smith was doubtless quite low. It is absolutely inconsequential so far as the patent shows to the contrary. In other words, the only refluxing you could get would be by the condensation which would occur in this very short pipe 18 and whatever might be obtained by the vapors hitting the top of the
1950 still.

In the process of this Smith patent if it op-
3901 erated as the patentee proposed, the brushes 27 in the still would tend to sweep the solid residue material towards the rear end of the still and that with the residue containing the baneful asphaltenes would pass down through this rear leg of the heater and be circulated around and around through the heating or cracking tubes.

Q. And, according to the patent, at intervals of 30 minutes or more you might bleed off some small

amount of that material through the pipe 25 and subject it to the filters 30; isn't that correct?

A. Well, I am looking to see if it said "small amounts." You said the patent said—

Q. Well, couldn't you tell it would be a small amount because it would be a division at least, part of it would go up through the cracking tubes and what would pass through the pipe 25 would be a small, relatively small bleed, wouldn't it?

A. Well, I don't find that taught. I would agree with you that it certainly isn't all removed into those filters, I do not think he is very specific as to how much.

3902 I recall that he only draws it out at 30 minute intervals and, except during those intervals, all the residue from this still, with the other oils present, circulates around and around and around through the cracking tubes.

Q. I understood from your testimony that you say that that valve 42 is not located in the place

3902 1951 that Biddison and Boyd desired to have it located. I don't know whether you are exercising clairvoyant powers in reaching that conclusion or not, but was that your contention?

A. I remember well my contention, but I don't remember that as my statement. I don't know what Biddison and Boyd thought. I said that the drawing and the thing as he indicated it would not permit the reflux from the partial condenser on the tar still to be returned directly to the tar still as he teaches, with that valve in that position, or he might have set that return line from that partial condenser in

3903 that position. I don't mean to say with the valve 42 located exactly where it is located in this patent, the process would be inoperative, but you would not follow the specific teaching of Biddison and Boyd in his two unclean circulation processes if you left it just there. I suggested that if it were put in some other spot then the teachings of Biddison and Boyd could be followed.

Q. Will you kindly indicate on Figure 1 of the exhibit patent the spot where you say the valve 42

3904 should be located, and I would suggest that in doing that you draw a leader line from the spot and at

the outer end of the leader line put some sort of a reference character like the letter X.

A. Now Mr. Hall, I know exactly what you are driving at, because in making the simplified drawing, your Honor, this line 14 coming from the—to carry the reflux back to the tar still, if you will, in that simplified drawing we show that coming down to the very short, in this drawing of the patent, line connecting the still with the vertical line 10. And
3904 1952 in the simplified drawing we brought line 14 down to that line, so it was just a matter of moving the valve to the outside of the line in that simplified drawing. If, as Mr. Hall suggested several times, I had given close attention to the patent drawing instead of the simplified drawing, in that case I would have said to bring that line 14 down between this valve 42 and the tar still so that the reflux, as Biddison and Boyd teach, would be returned during the operation directly—the reflux would be returned
3905 directly to the tar still.

Of course, as it is now near the tar still, as it stands now while the tar still is in operation this valve 42 would be closed and the reflux coming down from this partial condenser, the vapors from the tar still would flow back into this line here and would, of course, go down to the pump and be pumped through. Might just as well not have had this partial condenser and condensed everything in the tar still and let it run down to 18 which would go to the pump.

3906 Q. Now, are you unable to indicate on Figure 1 the spot where you would put the valve 42 rather than the spot that Biddison and Boyd put it?

A. No, in reference to the drawing of the patent. I would be content to leave the valve there and bring that line 14 carrying the reflux from the tar still distillation back to a point between the valve 42 and the tar still. They are very close together.

Q. Well, then you can not effect this change
3906 1953 that you had in mind merely by changing the valve 42 from the position it now occupies on Figure 1 to some other position on that figure.

A. No, Mr. Hall. I indicated that. I was talking when I made that suggested change—

Q. Will you just say yes or no?

A. No, I want to finish that if I may. When I

made the suggestion of changing the valve I was talking specifically and particularly from the simplified drawing. The difference in the relation of those lines has nothing to do with the operation itself and it was entirely correct in reference to the simplified drawing.

3907 Q. Well, I am not concerned at all with your explanations now. On your direct examination you suggested a change in the position of the valve 42. Now all I am asking you to do is to take the drawing of the Biddison and Boyd patent and indicate the spot where you propose to relocate the valve 42. Can you do that or can you not?

A. No, I don't think I said it could be done.

Q. All right. But did you propose to change the position of the valve 42 when you gave your explanation of this Biddison and Boyd patent on your direct examination?

A. I did, referring specifically to the simplified drawing.

On my direct examination I referred to a patent, British patent granted to Haddan, which I called the

3908 Benton patent. I think that it is correct that

1954 patentee, Benton, as shown by the patent, was a resident of Titusville, Pennsylvania, United States of America. It is so stated in the specification and I knew that he had a United States patent which was granted the year before the British patent, and which discloses the identical apparatus of the British patent. I referred only to this British patent and not to the United States patent because it was a very early reference that covered only the disclosure of cracking in a tube, and largely if not entirely in liquid phase, and it was very much simpler—it was stated in a much simpler manner in the British patent, easy to follow, easy to explain, that was the chief reason. The United States patent is No. 342,564 and it was issued May 25, 1886;

3909 1955 Q. And as disclosed in this United States patent, the invention is for converting benzine into an illuminating oil, is it not?

A. Well, I have not, as a matter of fact, given this very much attention. I have some marks on it here. I will just review it for a minute, if I may.

The Court: It says in line 8: "My invention relates to an improved method of refining crude petroleum that is extracted directly from the earth in contradistinction to that which has undergone the usual primary distillation before refinement."

Mr. Hall: The next paragraph, if your Honor please. "The object of my invention"—

A. I will continue to read that.

"The object of my inventoin is to confine the crude petroleum under high heat and pressure so as to cause a thorough chemical union or combination of the different homologous hydrocarbons comprising the same,"

I recall now, Mr. Hall, when you asked me first it had completely slipped my mind,—in this United
3910 States patent, Benton has what I would certainly consider to be an entirely false theory. He thought, your Honor, that if he took the crude as it comes from the ground containing, as we have often said here, gasolines, kerosenes, and other things, and if he heated that to a point where—I am not even sure he said where, where some cracking takes place,
3910 1956 but at higher temperatures and kept them in liquid under pressure, that he would cause a combination between—a chemical combination between some of these materials and thereby increase the material that could be recovered as his final product.

I will answer your question back a bit further, Mr. Hall, because I did not like that theory was another reason why I chose the British patent and not the United States, because that theory is entirely lacking in the British patent.

Well, at first glance the apparatus in the United States patent and that of the British patent look to
3911 be exactly alike. I would have to consider them. I have not checked it in detail. Well, I see they are not photostatic copies but they certainly are substantially the same but they are definitely not copies of each other. As to the process, irrespective of the results which Benton teaches in the United States patent he seeks to obtain, the thing he does is the same. Yes, I will say the processes are the same. I would not think he got a different result in one than the

other either, but I have not checked temperatures
3912 and pressures and things, to be sure of that. I did not say the processes were the same. I said, insofar
3913 as temperatures and pressures may be different. I might have to change that, or whatever it was I said at the end of that. Regarding the actual temperature which this Haddan patent, which I call the Benton, teaches one to use as the oil temperature, as the
3914 oil passes through the coil B, I find no specific teaching. Of course, there are other instructions that
3914 1957 would help you follow his teaching even without that. As to pressure, on page 1 of the complete specification, line 18, he suggests 285 pounds or more to the square inch to be imposed upon the oil in the pipe B. As to the pressure maintained in the chamber C just below in 22 on that same page,

"The vapor-chamber C which may be under pressure of one atmosphere, or which may be exhausted to any lower pressure as desired, a rapid evaporation of the heated hydrocarbons is effected."

That is, it is either under atmospheric pressure or subatmospheric pressure. The patent refers to the use as a charging stock of refuse of petroleum oil. I
3915 understand that to be the language of a long time ago, before my time, but I suppose that would mean the materials which were not then readily sold, the things perhaps heavier than kerosenes. It also refers to tar oils; that is much more definite because at that date, of course, there was illuminating gas being made from coal and these tarry oils were one of the by-products of such distillation of coal. Then it says: "Other heavy mineral oils". Referring to that, there are plenty of others that would not perhaps be classed as a refuse from the kerosene distillation which was the chief petroleum refining step at that time. It might be the gas oil cut between kerosene which definitely was unsalable and the lubricating fractions for which, of course, there was some market at that date, 1887.

Q. You would say that in this paragraph where he specifies the oils he contemplates using that he
3916 1958 did not intend to include crude petroleum?

A. Well, of course, he mentioned crude petroleum right in that same sentence, but I am sure

that he mentions crude petroleum in another sense and I don't believe for a moment he means he is going to use crude petroleum containing its gasoline and kerosene as a charging stock for the cracking process which he describes. That is the second process which he suggests very clearly in this patent his apparatus can be used for.

Q. Will you read without comment of your own the part of the specification which describes cracking?

A. On page 1 of the complete specification, line 7: "This invention consists of a method and means for producing lighter hydrocarbons from the refuse of petroleum oil, tar-oils and other heavy mineral oils"—

Q. Now, would that not be possible by straight
17 distillation and hasn't that been done for at least the last fifty years, producing lighter oil from heavier oil by straight distillation?

A. Well, I don't think that language producing from "other heavy mineral oils" indicates just that although, of course, I know that the total mineral oil with the kerosene in it is heavier than the kerosene itself, but I cannot believe that Mr. Benton means that particularly in view of his pressure discussion later.

17 1959 If I take ordinary crude oil and subject it to the ordinary straight distillation, I will produce lighter oil.

The Court: Would that "producing lighter hydrocarbons" include just simple separation by distillation?

Mr. Hall: I think so, if your Honor please. In
18 other words, you speak of conversion, that is the usual term. You convert it, not produce it.

The Court: All right.

A. Of course, Mr. Hall, there is another answer included in that same sentence, too. The last five words have little meaning unless they contrast this distillation operation which was then always or almost always referred to as refining crude petroleum. It seems to me that sentence, contrasting the simple distillation step from the other which he makes, is without question the cracking step.

3919 As I stated before, and I think in my direct as well, The specification does not give the oil temperature to be used for cracking. The patent requires that the chamber C shall be heated to avoid condensation of vapors which are generated in it.

Q. And that would require one, since that chamber is under atmospheric pressure or a vacuum, to pour heat through the bottom of chamber C in order to avoid any condensation of the vapors?

A. I do not know why it has to go through the bottom, and I don't know why the pressure or vacuum has anything to do about it. It certainly teaches
3920 1960 heating it so that condensation is prevented. Without answering in B. T. U.s per square foot, I can answer it this way, it would definitely require that same amount of heat as would be represented by the heat lost if the chamber were not insulated at all. It wouldn't require the same amount of heating which was initially required to produce the vapors; if any vapors did condense due to some cooling, the same amount of heat to revaporize those same vapors would, of course, be required. But we cannot possibly conceive that that would be more than a small amount of the total, therefore there is no relation between the total amount of heat going into the oil in the tube and the small amount required to prevent this condensation.

Q. If we assume that this patent was treating heavy mineral oil or tar oils and cracking it by passing it through the tube B at this pressure of 285 pounds or more, and then in the chamber C, we had a condition of sub-atmospheric pressure or in any event
3921 a pressure not greater than atmospheric pressure, wouldn't that produce a very heavy residue in the bottom of the chamber C?

A. The residue in the bottom of chamber C would, of course, depend on the type of material you are heating. It would depend, of course, on how fast you are pushing it through and the temperature at which it was heated, and it would be possible, of course, to heat it too hot and have too thick a material going through and to get such a heavy residue that you could not follow the teachings of the patent which are to withdraw that residue.

3921 1961 Q. But if we were putting the material through there, through the tubes B at such a rate to obtain anything like a substantial gasoline yield, and get a substantial amount of gasoline in a day's run, and we release all of that material in chamber C when it is under sub-atmospheric pressure and in any event a pressure not greater than atmospheric pressure, wouldn't we get a heavy, very heavy residue in the bottom of the chamber?

3922 A. Of course you have run this thing up a bit now to make gasoline. I don't think it is specifically stated he was making gasoline and at that date I would assume it was kerosene, but if you ran the temperature up as high as that and caused this rapid vaporization to occur within the chamber, as soon as the pressure were released, you would evaporate most of the material, you would evaporate the gasoline if you made any, and the kerosene and gas oil and they would all go over and leave behind residue heavy enough so you might want to consider the heating of that separating chamber C because he specifically teaches in the patent, of course, that that heavy residue is to flow out. I would not consider I was following his teachings if I made it so thick and tarry it would not flow out. Under the conditions that you have given me you would possibly get a very heavy residue at the bottom of chamber C. The 3923 bottom of that chamber C and the outlet No. 8 is as I said in my direct, in a hot spot. I could not conclude that that would rapidly carbonize the material in the pipe H so that you could not withdraw any material from the pipe. That would depend en- 3923 1962 tirely on the kind and amount of residue flowing through and whether or not we are going to assume that this diagrammatic drawing is to be taken as a hard and fast engineering set-up for such 3924 a construction, which I certainly would not do myself. I think with the drawing just as it is and with the very heavy residue which you specify in the case you are doing gasoline cracking, that you might be very thoughtful of the possibility of coking up. But if I arrived at a point where I did coke up and I were operating the thing, I would know I was not following Mr. Benton's teachings.

3925 Q. Referring now to the Greenstreet patent would it not be possible to obtain substantial cracking in the tanks 22 and the subsequent tanks 24 to 31 by heating the streams to a sufficient temperature and the proper proportioning of the heating between the two streams?

A. To a sufficient temperature, do you mean, please, Mr. Hall, and follow the teachings, the incidental teachings, of the patent at the same time?

Q. Well, I mean with the setup. Let us take par-
3926 ticularly, for example, Fig. 4, that setup. That will give us a general idea.

A. With nothing but figure 4 to look at?

Q. Assume that you are getting adiabatic conditions in these tanks 24 to 31, and you put sufficient heat into your oil going through the cracking coils and the topping coils, couldn't you get substantial cracking in 22 and in those tanks?

3926 1963 A. Of course that wouldn't be following Mr. Greenstreet, but there are temperatures at which that could be made to occur, yes. That could be done, but that would not be following my idea of what Greenstreet teaches.

3927 At page 3709 of my testimony regarding Greenstreet I said "and he heats the oil in those coils, the crude oil in those coils, as he says in his patent, up to the vaporizing point of the benzine fractions." That is so stated in the patent. The patent actually says that he heats the oil to at least a point above the vaporizing point of the benzine fractions, referring to page 2 in the paragraph commencing line 69 and he checks that on the first page as well and says, "about this vaporizing point." That was the same thing I was referring to when I said the patent said
3928 that he heats the oil up to the vaporizing point. Original claim 14 in the Greenstreet application says that the oil is heated in vapor form to a high temperature and subsequently to a series of adiabatic expansions and contractions. I would say that that had reference to the action which occurs in these tanks, so far as the adiabatic action is concerned, to these tanks 22 and 24 to 31. Now referring to original claim 7 of Greenstreet, or claim 7 in his original application, it says in substance that the oil is heated to a high

temperature so as to do the larger portion of the cracking, and then conducting the oil through a series of heat insulated expansion tanks to which
3929 1964 no extraneous heat is added to further crack the oil. You didn't use, of course, the same words as are in the claim. The claim is short. I read it:—

"The process of treating hydrocarbon oil which consists in heating said oil to cracking temperature—"

3930 Original claim 7 requires heating the oil to a cracking temperature and conducting it under pressure through a series of heat insulated expansion chambers to further crack the oil. Those heat insulated expansion chambers are the chambers 22 and 24 to 31.

3931 Q. Claim 7 of the original application specifies that the oil is cracked in its passage through tanks which in the patent drawings are designated 22 and 24 to 31. Do you agree with that?

A. That claim refers to those tanks and says that further cracking occurs. It doesn't say how much.

Q. Yes, and you agree, do you, that cracking does occur in those tanks?

A. You don't want me to answer that yes or no, do you because you said "tanks" and that means all the tanks.

3932 Q. All right, tanks 22 and 24 to 31.

A. If you want me to answer that yes or no, referring to the whole of those, I will have to say no, because I am certain that no cracking of any kind occurs in the last tank. Taking the tanks or chambers 22 and 24 to 30 as a group, now, and not saying how much I have already answered that in my direct. I said that some incipient cracking took place. The patent does not itself specify whether this is
3932 1965 incipient or how much of the total cracking is done in the tanks and how much is done outside of the tanks and does not so state.

Referring to the amendment of June 16, 1924, re-
3933 ceived in the patent office June 16, 1924 and to page 11 of that, and reading from that paper as follows: "Applicant's process, therefore, is an automatic cycle movement beginning with the topping movement to remove the benzine fraction and followed with successive crecking operations carried out both in the

furnace and in the heat insulated, separated and con-
3934 secutively arranged chambers, to attain the highest available light oil derivable from the heavy hydrocarbons originally used." The separate and consecutively arranged chambers here referred to would be the digesting tanks we have just been discussing, including, I think from that, the tanks 22 as well as those 24 to 31.

Q. Would you say 31, or would you stop at 30?

A. Well, of course, he isn't specific there. I assume he has just grouped the whole of them together. In the same paper, commencing at page 7, and in my bound copy it will be page 751, I find the following: "But the construction and description as referred to in the present application carry throughout strong emphasis of the secondary or subsequent cracking operation brought about by the heat insulation of the digestion or expansion tanks employed." The
3935 1966 tanks which are there referred to are still that series of several digesters. Referring to claim 4 of the patent, the part reading, "all of the tanks being heat insulated to conserve the heat energy of the oil vapors and permit the additional cracking thereof." The tanks there referred to are these same tanks 22 to 30. The number of the pressure control valve of the Greenstreet patent is 47.

The words of the patent do not specifically state what is the character of the cracking stock or the oil which passes through the cracking coils, except indirectly and most concisely at line 90, page 2, in which the tank holding the materials charged to the cracking coils is called "distillate storage tank." As
3936 to the character of that distillate, as to boiling range or gravity, I think we can be reasonably sure that since the material in that distillate tank is a mixture of the oils heavier than the gasolines distilled out of the crude and condensed in the fractionating tower, that the light end would be as light as the kerosene. Of course some of the kerosene might find its way into what we have been calling here pressure distillate, but it would be kerosene for the beginning of that. Then since he doesn't describe in detail the exact composition, gravity and so on, of the residue withdrawn from tank 22 we cannot be certain of the

amount of the total rest of the crude that was carried overhead in that distillation, but it seems unreasonable to suppose that all of the gas oil fractions, all of the readily vaporizable materials in the crude, would not have been taken overhead to that tank.

1967 I am somewhat familiar with steam boiler
3937 practice. I don't know the Wicks type of boiler by name. What type is it?

Q. That is the type that has a large cylindrical head at opposite ends, and those heads are connected by small heating tubes through which the furnace gases pass or pass in contact with the tubes.

A. A fire tube boiler?

Q. Yes.

A. The hot gases go through it?

Q. No, not going through these tubes. They go around the tubes and heat them, and they have a cylindrical head at each end for your water that circulates up, and there is a body of water in the upper head.

A. I don't know it by name. I don't recall just that. I am perfectly familiar with water tube boilers where they do have a large head and a body of
3938 water, heated water, in that head, from which the vapors which are formed pass off to the point of use; most any boiler would have that, and many boilers have tubes. I don't just know that particular one. Usually that head is made large enough in a vertical direction so that entrainment can drop out.

Q. Now, in that practice, in that boiler tube practice or the boiler practice, don't they frequently put in the path of the vapors, the path that the vapors travel to the point of use, plates called baffle plates to knock out entrainment?

3938 1968 A. You didn't mean in the lines, in the steam lines?

Q. Well, at some point before you get to the actual steam lines, so it will knock out entrainment?

A. I don't think I have seen that in use but I can conceive of it being reasonable practice. I am thor-
3939 oughly familiar with the use of ordinary plates put in the path of vapors which rise from a body of liquid and knocking out entrainment. I don't recall right this minute where I saw a practice of that sort.

I think that is a common ordinary every day thing. To understand and have in mind—I don't know where I first saw that. But that is a common practice. Your small particles of water—and there would be small particles as a rule which would be carried entrained in the vapors—they would hit the baffle plates and coalesce, that is these small particles would form larger particles, we will say, and then run down the baffle plates or fall off the baffle plates back into the main body of liquid; that is the purpose of such baffle plates. That is in general the way they act, the way
3940 that action takes place, these baffle plates knocking out the entrainment. The idea of the baffle plate, of course, is to bring the vapors containing entrained, unvaporized particles in contact with the surface, and generally these baffles are arranged so that the direction of the vapor stream would be changed, one baffle coming from one side and another somewhat above it and coming from the other side, and so on, built up through so that you would get a tor-
3940 1969 tuous passage and many changes in direction, to bring about the thing you are describing. That has been used in cracking apparatus.

Q. Are you familiar with the old Adams cracking patents wherein the vapor line they had a knockout box with baffles in it to knock out the entrained oil and carry it back to the original source?

A. Well, I know that I have been familiar with the Adams patents. I just can't see that right this
3941 minute, but I can again conceive of that use for that purpose. Of course I couldn't agree with the fact that that coalescence of these smaller particles on a baffle plate or a knockout-plate is frequently referred to as condensing. I couldn't bring myself to use that term there and I don't know where I have read it in an authoritative plate, where knocking out entrainment was called condensation, because it is not condensation. I have known Dr. Rittman since about 1922 or 1923. I have consulted with him frequently in the course of the last few months in this preparation for giving my testimony in this case. He is a well recognized outstanding oil refining technologist, in my opinion. I would certainly so recognize him.

Testimony Under The Rule.

3949 1970 Q. I now call your attention to the record in evidence in this case of the testimony taken in the Universal Oil Products Company *vs.* Root Refining Company, Volume 3, and to the testimony of Dr. Rittman on cross examination which occurs on pages 1568 to 1569, and ask you first, in order to save time, whether Dr. Rittman was there discussing this action which occurs in connection with entrained oil particles striking a baffle plate and those particles coalescing and forming larger particles and falling back into the material.

3951 The Witness: That was the subject of the two or three pages in this vicinity of that testimony.

Q. Now, do you find that Dr. Rittman was asked and answered as follows, in considering that subject:

"XQ. 1590. So far as you are now advised you do not know of any case where the word 'condensing' has been used to define this action where the small entrained particles go together to form a large particle?

"A. I have not the slightest doubt that that is used in that way by probably many people."

Q. Do you find that there?

A. That occurs in the record.

Q. Does that portion of the record cause you to change your opinion that the word "condensed" as you found it in the Pielsticker patents, in con-

3952 1971 nection with the action of the dome, necessarily means that the dome is not imbedded in the furnace setting but acts as an ordinary condenser?

A. You would have made that easier if you had not tied that all up with the Pielsticker patent and talked about condensation and entrainment and knock-out. I would rather answer that in two steps.

Q. Well, you answer that as you see fit.

A. I look back in this testimony of Dr. Rittman's and find that he himself doesn't agree in his own mind that entrainment should be considered condensation, and then he makes the statement which you have just read, and that of course is referring to the subject in general. I myself have doubt that it is used this way by a great many people, because

I can honestly say I have never heard it used that way, and I don't know to what Dr. Rittman is referring when he makes that statement.

(End of Rule.)

3953 1972 In reference to the Pielsticker patents, the British patent of January 24, 1891, and the American patent or United States patent of June 14, 1892, in neither specifications is the statement that cracking occurs in the coil marked *p* in each patent specifically made. Referring now to the United States patent, commencing line 106, page 2, there reference is made to the creation of pressure in the retort L. In order to obtain this pressure three plans are given. One of these plans is the use of a
3954 steam blast. I never have tried to do that. I would consider, of course, the two others much easier alternatives. I wouldn't think he could maintain a very high or very satisfactory pressure in his coils by blowing a blast of steam against the coils. I assume right at the outlet of the coil and the entrance into the retort he could keep a back pressure on it of a few pounds, but I don't know how much he might keep. Here I referred to the coils shown in figure 2, labeled D, through which the heated oil and vapors pass and from that coil D enter the retort L. This sentence to which you called my attention, occurring
3955 on page 2 of the Pielsticker patent, has reference to the pressure in the retort. The pressure that could be created in that retort L by this steam blast scheme would, of course, depend on the steam pressure and the relative spacing and size of the steam pipe, and how far the valve was open, and what not, and
3955 1973 I haven't any idea, but I will give you a few pounds. I think with 100 pounds of steam blowing in there it would be perfectly easy to get 20 or even up to 50 pounds held behind.

Q. In other words, you could raise the pressure in the retort L 50 pounds or 100 pounds, did you say?

A. No.

1974 Q. 50 pounds, by the introduction of a steam blast into the goose neck S, is that correct?

A. That is just a guess. I haven't any way of knowing that. I never have tried it.

3956 Q. Now, is it your contention that this sentence where it refers to the production of a still lighter gravity oil by means of this added pressure connotes that there is cracking going on?

A. Well, he is talking of a distillatory process and teaches in that paragraph the desirability of keeping the oil so distilling under pressure, which is the kind of an operation that we would normally consider a cracking operation in contra-distinction to an ordinary atmospheric pressure distillation. That indicates to my mind that that is a cracking operation, what is set forth in that sentence commencing line 106; that is one of the teachings of the patent.

Q. This patent refers in the first full paragraph of the first column on page 3 to the use of the apparatus for distilling fats and oils and the separation of fatty acids and glycerine, and also for the continuous production of distilled water from sea water, or the
3957 concentration of brine and alkaline solutions, and the concentration of sugar solutions. Would not a means on the outlet from an ordinary distillation apparatus treating sea water, a means for increasing the pressure in the retort, have utility?

A. In connection with distilling water we put the material we are boiling under pressure?

Q. Under a slight pressure?

3957 1975 A. I can't imagine any reason why. There of course might be some resistance going through the condenser coils. It would all depend upon what you had for a condenser coil. Whether there would be a pound or two of pressure there wouldn't matter.

Q. But you don't know of any reason why one would desire to put a slight pressure on the pipe S which discharges the vapors from the retort L, as shown in Fig. 6 of the Pielsticker patent, unless he was carrying out a cracking operation, is that correct?

A. I think definitely that is correct, in view of the general disclosure in Pielsticker's time and the art in which he was interested. Pielsticker's time was
3958 about half a century ago.

Q. Now, in these patents, wherever there is a

complete assembly shown, that is a furnace setting and the retort L in the furnace setting, the dome on top of the still from which the vapor line leads is imbedded in the wall of the furnace setting?

A. Yes. I consider that to be one of the alternative measures which he suggests.

Q. Is there any description in either of these patents in the specifications that in itself says that were the dome of Fig. 3 of the British patent or Fig. 5 of the United States patent substituted for the dome of Figs. 2 and 9 of the British patent or Figs. 4 and 11 of the United States patent, such dome of 3 and 5 would be differently located from that which it occupies as stated in Figs. 2 and 9 and 4 and 11?

1976 A. In words stating to use the dome P with
3959 the enlarged base and with the baffles shown to hold the vapors out against the surface of that dome in continuous contact, there is no word in the patent which states to locate it differently except the point we have just disagreed on, that condensation is taught in that dome which means cooling, and which wouldn't occur if you put that dome P down inside the furnace setting or insulated it heavily.

If you arranged it in the furnace setting as shown it is a possibility that you would get some condensation from the vapors striking against the under-surface of the exposed top of the dome, I referred, in discussing the British patent, to claim 6 and particularly to the statement that the material collected in the cup at the bottom of the dome of Fig. 3 might be returned to the heating coil. Now, in the later filed application for patent which matured in the United States patent 477,153, I find no reference to that at
3960 any place. I produced a drawing, or a drawing was called to my attention and offered in evidence as Defendant's Exhibit 791, I said I had this drawing made.

Q. Well, in having it made didn't you follow what is virtually a replica of it which was placed in evidence by the defendant in the Universal *vs.* Root case?

A. Mr. Hall, both drawings were taken from the individual units of apparatus shown in the patent and therefore look much alike, but if you will compare them you will find they are different. It is

pretty hard to make two things just like one thing different. My point is they are different, however.

3961 1977 Q. In other words, you were not guided in the arrangement you show in Defendant's Exhibit 791 by the drawing which was used by the defendant in the Root case, but that is your original thought that you have pictured in that Exhibit 791?

A. I think it is Mr. Pielsticker's original thought.

Q. Yes, but it is your original interpretation, your interpretation of what you think he discloses?

A. Well, I don't know that I can even say that. I saw the Root picture.

The Court: What difference does it make?

The Witness: I don't know that that is my original thought. I make the point that it is different, that is all.

I definitely do not find disclosed any place in either of the Pielsticker patents the part in this drawing, Defendant's Exhibit 791, which is marked "Reflux pump."

3962 Q. And do you find any place in either of the Pielsticker patents, either in the illustration or the specification, the valve that is in the line P' in Defendant's Exhibit 791?

A. There are no lines to any valves shown in the patent coming from the lip of the condenser. It simply states where to send the oils.

Mr. Thiess: In order that there won't be any misconception here, if you will look at the dome R there is a pipe shown but there is no valve. Is that right?

A. I knew there was a little short pipe but it did not lead anywhere and it had no valve.

3962 1978 If you are differentiating the specification from the claims, I find nothing in the Pielsticker specification, either the British patent or the U. S. patent, or in the drawings, which shows a reflux line connected into the entrance end of the pipe heater, such as I have shown in Defendant's Exhibit 791.

3963 Q. Now in the claim 6 which you are relying on in the British patent, does that say that that line

leading from the cup in the dome connects into the entrance end of the coil heater D?

A. He does not state to return that reflux oil to the front end or the beginning of the heating coil. He says to the heating coil. But since he differentiates that alternative point of return with that of returning it directly to the retort, it would seem that certainly means the entrance of the heating coil since putting it into the only other point possible, the exit, would be just like putting it in the retort. That is the construction I put upon it, but that is not actually stated in either patent.

3964 The Alexander patent, Defendant's Exhibit 806, teaches operating at atmospheric pressure. You have called my attention to page 2, column 1, line 47, to the following:

"I operate at about atmospheric pressure; using no more pressure in any event than is necessary to produce movement of my vapors. It is even better not to use this much pressure or indeed to use a slight degree of vacuum."

3964 1979 I would say from that that this patentee teaches that it is preferable to operate in any event and that this patentee intended to operate in any event not above atmospheric pressure and 3965 preferably below atmospheric pressure. I think I so stated in my direct; that is my understanding. I represented that the patent teaches, or the patent says that one may use a set-up of Figure 8 but substitute for the shell still there shown the coil which is shown in Figure 5. Referring to Defendant's Exhibit 808 I not only made this change but I introduced into what you call the reflux line what I have designated a reflux pump. I do not find that that patent also tells me in words to add a reflux pump, but the Figure 5 teaches me that. In describing the change that is to be made or the change which the patentee suggests one might make, the patent itself in words says nothing about it.

3966 Q. I would like to have you give us a typical set of operating conditions for running Figure 8 of the Alexander patent modified as you have suggested, and in that connection I desire to ask you a few questions, you having in mind what my object is. What

would you say would be a suitable oil for use as a charge for the apparatus modified as you have stated, giving me if you will, the gravity or approximate gravity and the approximate boiling range of the oil as you find that set forth in the patent?

A. Well, it seems to me I have a pretty wide choice as to the charge—This will be a topped crude without any gasoline or kerosene in it.

3966 1980 Q. All right. I am going to let you select the charge that you are going to run and as I
3967 stated to you I am going to try to carry you through a typical run of this patent in the way you would run it. So I am going to, so far as possible, give you the reins and I will first ask you about the charge you are going to use, so long as you keep yourself within the purview of the patent.

A. Well, I would use a topped crude from which I would expect to take overhead, oh, some 65 per cent of a material which we have broadly been classing as gas oil. The boiling range—Well, this is just picking it out of the air—it would depend entirely on what kind of crude we had.

Q. Well, I am letting you select that. You select the one that is most favorable to you.

A. Well, we will take 25 degree Baume a topped crude, and have it from Mid Continent and show an Engler distillation on the 65 per cent to be taken overhead. If I condensed that and made a distilla-
3968 tion it would reach, let us say, 700 degrees in the Engler flask at about 75 or 80 per cent over. We will assume we have taken out the gasoline and kerosene and the initial of that gas oil is 500 degrees and 75 per cent or 80 was over at 700 degrees, that is as far as I would carry it in the Engler glass flask, cracking goes on so rapidly from that. I cannot give about what the end point would be on the gas oil that I am going to use. Not from the question of a dis-
3968 1981 tillation that I would normally choose to make on it now because I cannot carry it beyond that point without cracking it. You could make a vacuum distillation and obtain, of course, a low temperature
3969 reading at the end of the distillation, it would distill then without cracking, and then by calculation you will get an idea at least of what the final end point

would have been if you had distilled it and it had not cracked in the ordinary atmospheric distillation. So if we had this gas oil we could find the initial and end boiling point by those means. I can approximate it at 200 more degrees, 900 degrees, I am not sure that is exactly right but it is in the range. 500 degrees initial and 900 end. As to the gravity, I would call that 28 Baume.

Q. Now, about the pressure in the apparatus, would that be following the teachings of the patent and, of course, always keeping in mind Figure 8 modified as you have suggested, would that be approximately atmospheric in all parts of the apparatus?

A. There would be some pressure drop, of course,
3970 in going through the coils; that is the pressure which the pump on the reflux line there was to overcome when you had the tubular heater. Depending entirely on the furnace design, the pressure could be within a wide range. I will take a typical one, 60 pounds, and that would be at the start of the coil which I have marked 75 in Defendant's Exhibit 808. From there on there must be enough pressure, of course, to carry it through the fractionating columns and dependent on their particular design a residual pressure of from 10 to 30 pounds at the dis-
3971 1982 charge end of the cracking tubes 113. Referring to page 2, line 71 we will take, to be specific, the 6-inch diameter cracking tubes. The patent says from 6 to 8 inches internal diameter and I am going
3972 to take the smaller one. I cannot give the length of the tube until we decide on how much oil you take through. To get a good or reasonable throughout per day let's take 500 barrels, we will say, of this
3973 crude per day, 500 barrels of this topped crude. Well, I would want around 200 feet of that 6-inch tubing then. I don't care much whether we put it in parallel, I mean have two passes as Alexander shows after the oil is vaporized, or whether we have it all in one length, it would not matter. I might have 100 feet in each one of the legs or a 200-feet single tube but I would specifically make my vaporizing section in one continuous passage, and for that—just a moment—oh, I will take 500 feet of 3-inch tubing for

the vaporizing section. Of course, that would be much shorter if I heated it more rapidly. Alexander
3974 gives me a good range of temperatures; at page 2, line 95, he says a temperature of 500° C., 932° F. in
3975 furnace chamber works well. I suggest the round number of 900 for the temperature of the vapors in the 6-inch diameter cracking tubes. That would be the temperature where the vapors leave the tubes. I had been, in my mind, assuming that the vapors in this cracking, larger cracking tube were somewhere near the same temperature all the way through, but that would be obviously raised somewhat and the vaporization temperature would be somewhat less than that. The oil, as taught by Alexander,
3975 1983 would completely vaporize out in the vaporizing section and you would not have to go as high as 900 degrees F. to vaporize those oils. An
3976 appropriate temperature, running this still in the way I would run it, of the vapors in the cracking tubes, would be 900 degrees at the end of the tube but extending approximately that temperature—you can make it an awful lot easier to do some figuring if you let it be that temperature all the way through. I cannot state how much cracking per pass is taught by Alexander but I think under these conditions I have an idea. Meaning cracking to gasoline in one pass through. I would have to make a guess unless I spend some real time with these figures that I am picking out of the air, but I would guess somewhere between 15 and 20 per cent possibly. Referring to
3977 the patent, page 1, line 21, and page 2, line 20, and lines 12 to 111 and page 3, line 114 he states, of course, all the way through that he desires to crack lightly and to get a low yield per pass; but he suggests that 10 per cent is disappearing as gas, tar and coke, at line 118, indicating a very low yield because if he in a vapor phase operation had a yield as high as I just suggested, he would make more of a loss than that. He would make 10 per cent of gas, and 6 per cent of the tars—I prefer not to calculate here how long a time the vapors would be in the tubes 113 to make the amount of cracking that I have stated at the temperature I have stated. I would rather take it home and bring it in the morning.

3978 1984 *Redirect Examination by Mr. Theiss.*

3983 In my cross-examination I was referred to original claim 14 of Greenstreet, and particularly to the adiabatic expansion and I was asked to give a yes or no answer and wished to make a further statement.

The only thing that I would have added to the answer I gave was that this idea of adiabatic expansions and contractions, was a thing that Greenstreet was a little mixed up on. He really thought that when his vapors passed through these, through that series of digester tanks with the sloping tubes that we have seen, that since the vapors went through a small tube, then through a large diameter digester and then through a small tube, that they were com-
3984 pressed and then expanded and it was after several communications and interchanges with the Examiner that he finally withdrew from that position of expansions and contractions.

3985 I would like to further say that adiabatic, of course, means without loss of heat or without picking up heat, and yet although these tanks are insulated, no such insulation is ever perfect and Greenstreet teaches that condensation does occur which indicates a lowering of the temperature, therefore they were not truly adiabatic.

3996 Mr. von Holst: I want to offer the file wrapper on this patent 1,688,654 that is in evidence as De-
3997 fendant's Exhibit 815. This file wrapper shows that the original application which ultimately matured into this patent, was filed on December 21, 1917, and has the same disclosure as that of the patent and throughout the word "vaporization" is used
1985 by the patentee. This Dubbs file wrapper is the one that belongs to Defendant's Exhibit 815, and is the original application upon which this Defendant's Exhibit 815 ultimately issued as appears from the statement right on the face of the patent, original application filed April 15, 1925, serial number 23389, which in turn is a division of serial number 595743 filed October 20, 1922, the latter being a continuation of serial number 208206 filed December

21, 1917, divided on this application filed August 18, 1928. So that I am offering the original application
3998 upon which Defendant's Exhibit 815 finally issued and for the same purpose and under the same authority.

Mr. Haight: Just a minute, it is an offer of the whole record, the whole file wrapper?

Mr. von Holst: The whole file wrapper on this one number 208206.

Mr. Haight: We object to that for the further reason that if we are to divine the purpose of this issue from what was done in the Delaware case, it is to use the arguments that were made by counsel in the prosecution of that patent which had nothing to do with the subject matter of the patent in issue.

Mr. von Holst: Your Honor, Judge Haight cannot misstate the purpose for which I offer an exhibit and say that mis-stated purpose is objectionable. I have not offered it for any such purpose. The offer is made in good faith and for the purpose that I state, to throw light upon the use of the word "vaporization" by Dubbs from that year, 1917, down 1986 through the period of the prosecution of the
3999 patent in suit and thereafter, and for no other purpose.

The Court: I do not think it is necessary. I have admitted the patent in evidence, and I think that is sufficient without burdening the record with other evidence of every use of the word "vaporization" every time that Dubbs used it. I do not think that is necessary. I have allowed the patent in but I do not think it is necessary.

Mr. von Holst: Your honor, it is not a question of offering it every time he used it. If we did that, we would come in with a stack of documents that high.

4000 The Court: I will sustain the objection. There is a rule under which you can put it in, but I will sustain the objection.

4001 Mr. von Holst: We offer the file wrapper of Dubbs application serial No. 208,206, as Defendant's Exhibit 816 for identification, under the rule.

(Said document was marked for identification Defendant's Exhibit 816.)

1987 CLARENCE K. REIMAN:

Direct Examination by Mr. Hall.

(Witness called in behalf of Plaintiff.)

3986 I was very well acquainted with Dr. Walker in his life-time, a good friend. I am also now acquainted with Dr. Lewis and Dr. McAdams. I recognize their work "Principles of Chemical Engineering", as being an authority.

1988 PLAINTIFF'S REBUTTAL PROOFS.

1989 GEORGE H. TABER*, Pittsburgh, Pennsylvania:

Direct Examination by Mr. Thomas.

4087 I was employed by the Gulf Refining Company in 1903 and remained until the time of my retirement which was 1928. I was first made general manager and then vice-president, with duties consisting of having charge of all refinery matters and of deep water shipping; in addition to which, I had full charge of oil distillation and cracking operations.

My first connection in the oil business was in April 1882 with the Queens County Oil Works at Long Is-
4088 land City. Shortly afterwards I was made assistant superintendent. Part of that time I was superintendent of the adjoining refinery, called the New York Refining Company. In 1885, I left that position and went with the Eclipse Lubricating Oil Company, Ltd. of Franklin, Pennsylvania, in charge of the paraffin wax business; shortly afterward was made assistant superintendent and then general superintendent. From there I went to the Atlantic Refining Company at Philadelphia in 1892, where I remained until 1903, to go as general manager of the Gulf Refining Company of Port Arthur, Texas, with offices in Pittsburgh.

4089 I employed Clive M. Alexander about 1915 for the Gulf Refining Company to develop a process of crack-

* This testimony, given in the case of *The Texas Co.* v. *Anderson-Prichard Oil Co.*, March 29, 1939, was used here by stipulation.

ing. He started with experimental apparatus which Gulf provided to carry out his ideas and afterwards a large plant was built at the expense of a million and a half dollars. This plant was installed about two years after Alexander was employed.

4090 After Alexander gave up in making a success of the large plant, several of the Gulf men tried a hand
1990 at it. Finally half of the plant was demolished and the other half was used for topping Mexican crude oil which is not a cracking operation.

One or two patents relating to this process were taken out in Mr. Alexander's name with the Gulf's help and at the Gulf's expense by the Gulf patent at-
4091 torneys, who were Messrs. McElroy and Houghton of Washington. The patent which I had reference to, DX 806, is No. 1,407,619 to Cliye M. Alexander of Port Arthur, Texas, and assigned on its face to the Gulf Refining Company.

Alexander had full charge of the supervision and
4092 operation of the plant. When we started we had a suitable charging stock. The operation of the plant was stopped because we ran out of suitable charging stock. The operation was not stopped because of any difficulties with products. The production of the operation from the material which it was handling was satisfactory as far as I can recall. The charging stock
4093 used was a 37 gravity light distillate containing a certain amount of free gasoline. The amount of cracking was small. After the Alexander plant was partly demolished and partly converted for the Mexican crude, it was never used for cracking operations.

4094 No one ever applied to the Gulf Refining Company for rights to operate under the Alexander patent.

1991 *Cross-Examination by Mr. Theiss.*

4096 I knew at the time, but I don't know now what particular process of the eight figures of the Alexander patent DX 806 was operated down there by Alexander. I took great pleasure in forgetting it. I had some other unpleasant experiences along this line.

The Aluminum Chloride which was also tried out was not a cracking process, in my opinion. I understand Gulf is using it very successfully and making an oil that cannot be matched by competitors. That is my

understanding, though I have no inside knowledge, I know nothing about the business of the company at the present time.

4097 I cannot call our experience with some Prichard-Henderson stills unpleasant. Building the Prichard-Henderson stills is what gave Mr. Crockett employment with us; he did fairly well in running it—better than anything we had at that time.

1992 DEAN G. MECHLING*, Charleston, West Virginia:

Direct Examination by Mr. Thomas.

4098 At present, I am employed by the Carbide and Carbon Chemicals Corporation. From the first of August 1914 until the middle of November, 1918, I was 4099 employed by the Gulf Refining Company at Port Arthur, Texas. I was assistant to Mr. Alexander in the operation of the plant at Port Arthur. Construction of the plant began the latter part of 1917 and the operation began the first part of 1918. The plant consisted of five units, each unit containing four cracking benches with ten cracking compartments to each bench, four cracking tubes to each compartment, with vaporizing furnaces, towers, condensing equipment, pumps, etc. There would be 160 cracking tubes in a 4100 unit and 800 in a plant. These tubes were six inch extra heavy steel pipe about 19 feet long.

The essential elements of the plant consisted of vaporizing furnaces composed of tubes and compartments through which the oil was pumped for vaporization and conducted in vapor form to manifolds to the tops of cracking tubes where the cracking was done. The vapor leaving the bottom of the cracking tubes passed into manifolds to the exchanger tower. A portion of the vapors condensed in the exchange tower. The remaining vapors passed out of the top of the exchanger tower to a point near the bottom of the fractionating tower and the vapors from the top of the fractionating tower were carried to condensers, receiving house and run tanks.

* This testimony, given in the case of *The Texas Co.* v. *Anderson-Prichard Oil Co.*, April 3, 1939, was used here by stipulation.

4101 There were two vaporizing furnaces for each
1993 unit. Each furnace had ten compartments and in each compartment there were eight 4-inch tubes approximately 20 feet in length, I believe. The oil entered into one end of the top row of 4 tubes which were connected by return bends at the other end of the compartment to the bottom 4 tubes which in turn were connected to a vapor header which again was connected to the headers of the adjacent furnaces.

4102 The oil from the vaporizing furnace went to the top of a cluster of four cracking tubes which were six inches in diameter and 19 feet long. At the top of the cracking tubes there was a small casting to distribute the vapors. The oil vapors from the bottom of the cracking tubes flowed to the exchanger tower
4103 which was eight feet in diameter and thirty feet tall. Each unit had two exchanger towers. One exchanger tower was used as a spare. Liquid accumulated in the bottom of the exchanger tower due to condensation. The exchanger towers contained a refractory tile packing. The vapors from the exchanger tower passed to the fractionating tower which was five feet in diameter and forty feet high.

4104 A great variety of charging stocks were tried in the Alexander process. Charge materials were 34 to 35 gravity distillate, heavy distillate, as well as 44 gravity distillate called kerosene distillate or kerosene stock used as charging stock. The 34 to 35 gravity material was found to be unsatisfactory for operation. We finally settled on approximately 41 gravity as the best stock which the process could handle for the reasons that it was more easily vaporized in the vaporizing furnaces and also formed much less coke in the vaporizing furnaces as well as in the cracking furnaces.

4105 1994 In the first month of operation, we tried a charging stock of 34 to 35 gravity but we found we had a great deal of difficulty in vaporizing it and also had carbon formation. Later, we used the lighter distillate as charging stock, from 40 to 44 gravity.

The piping of the plant was arranged so that fresh stock could be charged directly to the vaporizer furnace or to the top or bottom of the exchanger tower, or even into the bottom of the fractionating tower.

Practically all of these modes of operation were tried.

4106 In the normal operation, fresh feed was preheated to a temperature between 200 and 300° F., by passing through a heat exchanger countercurrent to the condensate leaving the bottom of the exchanger column. The exchanger tower is the first tower the vapors enter after leaving the cracking tubes. The feed was then introduced into the top row of the vaporizer tubes where heat was applied to vaporize the oil. The vapors leaving the vaporizer furnaces were at a temperature of 500 to 520° and were then introduced to the top of the vertical cracking tubes, wherein they

4107 were heated to a cracking temperature. The temperature as measured by pyrometers touching the outside walls of the tubes was 1000 to 1100° F. The vapors in the bottom of the cracking tubes were then passed to the bottom of the exchanger tower at a point about four feet above the oil level. The vapor entering the exchanger tower was about 800 to 850° F. The vapor

4108 leaving the exchanger tower passed to the bottom of the fractionating tower. At the top of the fractionating tower was a dephlegmator consisting of a water cooled shell tubular arrangement for the purpose of condensing higher boiling fractions which could

1995 not be included in the gasoline. From the top of the fractionating tower, the vapors went to a condenser.

4109 The ultimate yield of finished gasoline produced by the Alexander operation based on the charging stock was six or seven percent. The end point of the gasoline was 420° F. but the intermediate boiling points did not comply with the government specification at

4110 that time. This deficiency in the intermediate boiling points indicated that there was not enough low boiling constituents in the product.

The product that actually came over from the fractionating tower in the Alexander operation had an end point of 450 to 460° F. and contained a material heavier than finished gasoline.

The finished gasoline was blended with other refinery products.

4111 "Q. What was the nature of the product of the plant with respect to color, odor, ease of treating and other characteristics?

"A. In all those respects, it was satisfactory.

"Q. Do you recall how severe or how drastic treatment was required to bring it to satisfactory color?

"A. It was not difficult to treat. It required approximately three pounds of 98 per cent sulphuric acid per barrel and a subsequent neutralization with caustic soda, in settling tanks to drop out the sludge, and after neutralization it was conducted to a steam still where the finished product was obtained, the finished cracked product."

I had charge of the treating operation.

4112 The color of the treated gasoline from the Alexander plant was good.

We attempted, in the first three months of operations, to return condensates from the bottom of the fractionating tower or exchanger tower either alone or mixed with fresh feed, by pumping them to 1996 the vaporizers but we had a great deal of difficulty in vaporization and in carbon forma- 1997 tion.

Figure 5 of Alexander patent 1,407,619, DX 806, illustrates the pieces of equipment in the Alexander process.

4114 The vaporizing coils are represented by "75"; the cracking tubes, by "82"; the exchanger tower, by "79"; the fractionating tower, by "86"; and the final condenser, by "87." The operation according to Figure 5 was tried out sometime during the first three months of operation. In that operation, the feed to 4115 the vaporizing coils and the cracking tubes comes from the bottom of the exchanger tower "79." That flow was not employed at any time after the first three months of operation. There was one operation where the condensate from the fractionating tower, together with fresh feed, was introduced directly into the vaporizer.

4116 When liquid condensate from the bottom of fractionating tower "86" was sent directly to the vaporizing and cracking tubes, we found we had difficulty with vaporization and carbon formation in the vaporizer. After the first three months of operation, this mode of operation was not used.

In the normal operation, the fresh feed went from the tank directly to the vaporizer marked "75".

4117 The plant was still operating when I left the em-
4119 ploy of the Gulf Refining Company in November 1918. At that time the supply of satisfactory charging stock was becoming low.

1998 *Cross-Examination by Mr. Thiess.*

4123 The Carbon-Carbide Company of West Charleston sells gasoline and probably other oil products to the
4124 Pure Oil Company and has a chemical plant at Whiting, Indiana, that processes raw material from the Standard Oil Company of Indiana for making chemicals.

4125 The Texas Company asked me to come here and testify. I took it up with my immediate superiors before I came here and got permission from them.

4126 I reviewed some of the cracking operation and laboratory data referring to the operation that I have testified about. I reviewed it first in 1932 at the offices of counsel for Universal at the time of the Universal-
4127 Root trial. I again reviewed it in the past couple of months in Washington at the offices of Mr. Byrnes a patent attorney who arranged with my company that I come to Washington to review it.

Mr. Byrnes was with Bacon and Thomas in 1932.
4128 He has his own patent offices now. The second time that I reviewed this, I reviewed the same information that I had at Mr. Thomas's office originally. I went over it rather more roughly than I had done before, to refresh my memory: I have reviewed it again since then very casually at Mr. Schneider's office.

4129 1999 I will make a sketch of what I call the normal Alexander operation.

DX 831 represents the operation of the cracking unit for normal operations, and I have included on this sketch in red, some lines which show the opera-
4130 tion that we operated during the first three months, to the best of my recollection. 1 is a pump and the part marked 2 is a heat exchanger, in which the feed was preheated by the residuum which was withdrawn
4131 from the system. From the exchanger 2 you go into the coil vaporizer 3. The tubes in the vaporizer were manifolded. And then from the vaporizer 3, you go to the cracker, cracking coils 4, which were also mani-

folded. This is a section of the cracking tubes; there were four cracking tubes in each cluster. There were two vaporizing units for each cracking unit, two vaporizer furnaces for each cracking unit.

4132 The 4 top tubes were manifolded at one end to the four bottom tubes, making four parallel passes in each compartment. From the cracking coil 4 the material was delivered to the exchanger marked 5, and from the bottom of the exchanger residuum was withdrawn from the system through the line marked 6 by the pump 7 on the outlet line of the exchanger tower. The vapors left the exchanger tower and entered the fractionating tower marked 8. The product was withdrawn from the top of the exchanger tower, fractionating tower and went through the condenser

4133 which I have conventionally shown in the part marked 9. From the condenser, the condensable part of the product went to storage; the gas went to absorption towers. The material that was condensed in the

4133 2000 fractionating tower was passed through line 10, in our normal operation, to the top of the exchanger tower 5, so that in the normal operation, the condensate in our normal operation was fed into the exchanger tower and withdrawn from the system with the residue.

The red line marked 11 was not used in the normal operation. In the modified operation it was used as a

4134 means of returning the condensate from the exchanger tower to the vaporizing furnace, either by itself or admixed with fresh feed as well.

When we returned merely the residuum the fresh feed came through a pump and discharged through

4135 this line 13, valve 14 being closed, valve 15 being open. This line 13 charged into the exchanger tower 5. There are a number of different piping arrangements by which the feed could be handled. This pump at the outlet of the fractionating tower was used at the same time to pump condensate from the fractionating tower into the exchanger tower whereby we had to have another pump to transfer the oil from the bottom of the exchanger tower into the feed line going to the vaporizer. That was not our normal operation.

4136 DX 831 shows the way the tubes were manifolded in the cracking furnace, and I have described how they

were manifolded in the vaporizer. Changes were made in the manifolding of the vaporizing tubes at different times, but the outlets were always manifolded.

4138 In DX 832, sketch 1, characterized as the "Regular Operation", the condensate from the fractionating
4139 tower is discharged into the exchanger tower, and spread into the top of the exchanger tower. The
4139 2001 heavier boiling products come down to tower as liquid and the lighter vapors are carried over as vapor. The heavier products that come down with the liquid are withdrawn with the residue. That material that we put into the exchanger tower from the fractionating tower is clean stock. The heaviest parts of it would then mix with the residuum and would be withdrawn as residuum. The feed in the normal operation went direct to the vaporizer furnace and we had some troubles with this vaporizer furnace during
4140 all of these operations. The trouble there was carbon formation in the tubes and inability to vaporize completely at times.

Our trouble might have been because of this manifolding in the vaporizer. We were unable to properly regulate the flow of the material through all of the tubes evenly and heat the tubes evenly, consequently we got this carbonization. That was partially the trouble. Other trouble we had was when we tried to recirculate, return the condensates from either one of the towers, we had some difficulty with coke formation and vaporization. That is why we arrived at this regular operation.

4141 The object of transferring the condensate from the fractionating tower to the exchanger tower was to obtain the heat exchange between the hot vapors and this colder liquid. Whether there was any heat exchange there or not, or that was of engineering advantage, I can't say. In this regular operaiton, we actually returned that to the exchanger tower to throw the heavier vapors down and the material knocked down was withdrawn as residue.

4145 In DX 833, sketch 2, we returned part of the condensate from the fractionating tower with the
4145 2002 fresh feed, and the remaining part of the condensate was fed into the top of the exchanger tower. In other words, we split the material from the fractionating tower into two parts.

4146 I don't recall the method of regulation except valve regulation by hand. I don't know what part went into the exchanger tower and what part went into the feed line. The material that collected in the bottom of the exchanger tower, in DX 833, the same as in DX 832, was withdrawn from the system as residuum. The only difference between DX 832 and DX 833 is that in sketch DX 833 we returned part of our clean condensate and put it through with the feed.

4147 In DX 835, sketch 4, we returned part of the condensate from exchanger tower with fresh feed. In that operation we again returned all the clean stock from the fractionating tower into the exchanger tower. We operated the exchanger tower the same as we did in the drawing shown on DX 832, in that the part of the clean stock thus fed to the exchanger tower which condensed was withdrawn as residuum.

DX 835 is the same as DX 833, with the exception that part of the condensate from the exchanger tower joins the fresh feed instead of the part of the condensate from the fractionating tower joining the fresh

4148 feed. The material that we withdrew from the bottom of the exchanger tower was a combination of the clean stock which was returned from the fractionating tower into the exchanger tower and a part of the effluent from the cracking furnace; in other words, the condensable ends of those two fractions were returned in part to the vaporizing furnace. The remaining

4148 2003 portion of the materials that were condensed in the exchanger tower were withdrawn as residuum. I don't know what part of the material that was returned from the exchanger tower was withdrawn and what part returned to the vaporizer.

I am not sure of DX 834, my sketch 3. I don't know about that operation.

4149 I previously gave some temperatures. I can put those temperatures and pressures on the operation of DX 832, the regular operation. 505-520 is temperature of the vapor entering the top of the cracking tube; 750 to 800 F. is at the entrance to the exchanger. And the temperature of the material that was fed into the vaporizer was 200 to 300 degrees F. The temperature in the bottom of the exchanger tower would not be as high as 750 to 800. I do not know what the temperature was at the bottom of the fractionating tower.

4150 In pumping this oil from the bottom of the fractionating tower to the top of the exchanger tower we used a Kinney rotary type pump designed for hot oil use. I don't know how hot that oil was. I don't recall having had trouble with the pump. The operating pressure in this apparatus as the oil entered the vaporizers was approximately 20 pounds. I don't recall what it was at the exit of the vaporizers.

4151 The DX 833 and 835 operations were not used after the first three months of operation. They may have been used intermittently for the period of time they were used. I don't know whether it was two days or three days or what it was.

The regular operation was the operation after the
4152 first three months as long as I was connected with this cracking process.

4152 2004 As far as I knew, the material or the condensate that came from the fractionating tower in all these operations was a clean stock. I called that a clean stock in the Root case. It apparently had no particles of carbon that would settle out. We made no tests for carbon by present day methods, but by observing the appearance of oil in a bottle it was apparently clean. It was rather dark but I could not determine any carbon in suspension.

4153 In the Root case on page 1972 of the record, I testified:

"During the first three months of operation we operated both ways.

"I don't know which came first. I would assume that the dirty stuff was tried first and then we tried the clean stuff. At the end of three months we discontinued returning any condensate from either of the columns.

"During the direct testimony I said that during the first three months we operated according to Figure 8, which is the returning of the clean stuff and then we changed our operation.

"We tried both ways in the first three months, returning both at different times. During the first three months we operated mostly on returning the clean stock. And then we found that that was un-
4154 satisfactory, because we got carbon in our tubes.

"I do not remember whether the return of dirty

stuff came first or whether the clean stuff came first. They were both tried.

"I remember we tried both ways of returning these condensates, and being fourteen years ago it is pretty difficult to remember which was tried first and which was tried second."

The dirty stuff referred to in this testimony was the condensate from the exchanger tower. To the best of my recollection, I meant the dirty stuff as the condensate from the exchanger tower and the clean stuff as the condensate from the fractionating tower.

4154 2005 "Q. Do you remember that you were asked about difficulties you had with carbon formation in the vaporizing tubes, and as you have testified here, 4155 you said that was due to those manifolded tubes, that is why you got your carbon, is that correct?

"A. I said we had more trouble with the carbon during those times that we were returning either of these condensates from the exchanger or the fractionating tower.

"Q. That difficulty was obtained in the vaporizing tubes, was it not?

"A. We got more carbon during those times in the vaporizer tubes and the cracking tubes, as well.

"Q. And the difficulty was due to the manifolding, was it not?

"A. I don't know that that was the full difficulty."

In the Root case, record page 1974, I testified:

"We had coke formation in these tubes when we used a perfectly clean stock; that is, the clean stock from the dephlegmator.

"The reason I think we got this coke was that these vaporizers were composed of 10 compartments for each vaporizer furnace, and in each compartment were four parallel passes. The oil was fed through 4156 a common header to these parallel passes with the intention that it would be distributed so that it is almost impossible to distribute liquid forty parallel passes. There were forty parallel passes to one vaporizing furnace.

"I do not know if that had been a single tube, whether or not we would have had this carbon trouble. I have never tried that."

I believe the manifolding of these tubes caused part of the carbon trouble. We had coke formation trou-

ble all through the operation, even after we discontinued the use of the return of the tower condensates. But not as much coke formation, coke trouble, in both vaporizing furnace and cracking furnace as
4156 2006 when we tried to return the condensates.

I don't know to what extent this coke formation increased in the operation when we conducted
4157 it as shown on DX 835, in which we returned part of the condensate from the exchanger tower with fresh feed. I don't know to what extent our coke troubles increased when we merely returned part of the fresh clean condensate as shown on DX 833. I don't know to what extent the carbon troubles were different in the operation of DX 832, which was the regular operation, and the operation shown on DX 833 and 835, but I know that the carbon formation was greater. Our furnace cleaning problem was much more severe in those times than it was when we adopted the fresh feed system.

The fresh feed that we fed to our coils was a stock,
4158 varying from 34, 35 gravity, up as high as 44 at times, kerosene stock.

4159 The boiling range of the charging stock which we used for the Alexander operation extended from around 230 Fahrenheit to above 550 Fahrenheit. I do not know what percentage we got off at 410 Fahrenheit.

Referring to the data which I have produced there is one charge gravity 40.9 which was fed to the vaporizer on this particular day. I cannot tell you the percentage off at 410 because 410 is not designated.
4160 14 is the percentage off at 392. I made that calculation.

I don't see any charging stock with as high a percentage off as 46 to 50. Maybe some of them are as
4161 high as 21. Some of the data sheets that were produced show a higher percentage off at 392. Here
4161 2007 is one at 51, 49, 64. That means 51 per cent; one, 61 per cent, one 63, one 61, one 62, 53, 32; now, this unusually high gravity stock includes nine days. I don't believe there are any more of that low boiling range; I don't recall the use of that kind of stock or the purpose of it at all. But it is part of
4162 the material that my counsel produced as stock fed to the Alexander unit.

4163 I don't recall a stock down there from which we got off ten per cent at 370; 20 per cent at 382; 30 per cent 396 and 40 per cent at 410. There will be a variation in percentages off and on through this thing, but the average will be, I would say, around 22 maybe, or 23 for the whole period of operations. I have forgotten about those. It might be as high as 30. Under those circumstances that would mean 30 per cent of material within the gasoline boiling range in the charging stock. That was the measure used by the lab-
4164 oratory in determining the gasoline content of a stock.

4165 Our yield of six to eight per cent that I gave was the yield as a result of cracking. That is my conception of it. And that did not include, of course, the gasoline that was in the stock which might have been 30 per cent. Then, I presume, the six to eight per cent was made from the 70 per cent that was not gasoline in the stock.

4167 If we had 30 per cent gasoline in our stock and had six to eight per cent more, when we got through with our combined topping and cracking operation, we had 36 to 38% and six to seven per cent would very likely have come from the 70 per cent.

4168 I don't believe that the color of our ultimate yield would be affected if there was 30 per cent of
4168 2008 natural gasoline in your charging stock, and we had only six per cent to seven per cent of cracked gasoline.

This gasoline that came off the unit as cracked distillate, that was the condensate from the top of the fractionating tower. That was treated—it was a very yellow product when it came over. It was treated with sulphuric acid, caustic soda, steam distillation and gave a product plus 24, Saybolt.

I know the natural gasoline in the distillate was not of great benefit in the treating operation. I have
4169 seen cracked gasoline, made from a stock that contained no gasoline boiling fractions, treated, and resulted in color as good as this Alexander product. That is my reason for that belief.

"Q. You knew, did you not, or you agree, do you not, that on or about from 1915, '16, '17 and '18, that it was generally understood that it was hard to treat vapor phase cracked distillate?

"A. It was not hard for us.

"Q. You had no difficulty.

"A. No difficulty.

"Q. And who was responsible for the operation of that treatment?

"A. I was responsible.

"Q. Do you know whether it was generally understood by others—

"A. The others did not know how to do it."

4170 This vapor phase gasoline that was being made down there on this Alexander project is the only vapor phase I knew of at that time. I have treated vapor phase gasoline since then. Vapor phase gasoline produced today may be treated by my process. Vapor phase gasoline is not hard to treat. It wasn't then.

4171 2009 Of these Alexander units built at the same time there were ultimately five units. There was very little variation, as I recall, made in those units.

In these reports, signed by Mr. Alexander, respect-
4172 ing this operation, on sheet marked 7-26 there is the note, "Unit 5 had to be shut down to repair faulty construction of main vapor line from towers." On page marked 7-27, appears "Collapsed fire boxes, faulty construction." On the next page, 7-29, collapsed fire boxes, broken line and faulty construction appears. On the next page, collapsed fire boxes and faulty construction appear. On page 7-30 "collapsed fire boxes and faulty construction." Then again on the next page, 7-31, I find "collapsed fire
4173 boxes and faulty construction."

I remember rebuilding fire boxes and baffles, but I cannot recall the changes if any made. We had no difficulty with the temperature regulator after get-
4174 ting the thing in operation; we had the usual starting up difficulties of control apparatus.

In one of Mr. Alexander's reports, he says, "There has been much difficulty with power control due to water boiling over. This puts cracked distillate tank off test; automatic control is necessary as planned." Again there is a note, "regulation not good on either unit, automatic tower regulators failing to work, starting up on unit 2 they held up for lack of condenser water." The date of that report is 3-5; it doesn't give the year. On a report marked 3-13, I

find "regulation of tower cooling water is difficult without automatic regulators." Again on a report marked 4-18, "temperature regulators not properly adjusted yet."

4175 2010 In a letter dated January 1, 1918, written to Mr. G. L. Prichard, General Superintendent, by Mr. Alexander, I find "Tubes and one vaporizer section burned out; this was probably caused by dirt in the line stopping up nozzles and over-firing while these were out for cleaning." The nozzles were on the inlet of the vaporizer tubes. We had trouble with those plugging up as a result of dirt. January 1st, 1918, was the date of the starting of the first unit,
4176 and hat could very probably be due to scale in either the new pipe lines, I don't recall the nature of that dirt. I also see in this letter that the return bends still leak at the flanges. And that the tubes leaked in the dephlegmator.

4177 We had an experimental treating plant of a semi-commercial size in 1917. Some of that money spent on this Alexander plant was also spent on the treating plant, but I have no idea what it was.

4178 A report marked "10-15" says "750 barrels of cracked gasoline made was off color, and was run into a cracked distillate tank." We did not have many of those as I recall. But we did have some of that type. Another report on 10-25, signed by Alexander, says "off color, canceled run but cracked distillate."

I have no recollection of how much of that material was off color. A very small percentage of it though,
4179 during the operation of that plant. Towers in refinery work will give trouble at times. We did not have much trouble with our towers.

The high boiling characteristics of this gasoline made on this Alexander process was due to the naphtha or heavy gasoline present in the charged stock.

2011 *Redirect Examination by Mr. Thomas.*

4180 The reports referred to on cross-examination, beginning with July 27th and extending to July 31st, with reference to "collapsed fire boxes and faulty construction," refer only to Units 4, 5 and not to the other units.

2012 *Recross Examination by Mr. Thiess.*

4181 Units 1 to 5 were all built generally alike. I do not recall any real difference between them. There might have been some variation in the baffling or some of the brick work.

4182 I do not recall having the same trouble with Units 1, 2 and 3 that we had with 4 and 5. I recall the troubles in the starting up of the plant, different phases throughout the operation, but I can't say whether we had the same troubles.

"Q. You did not remember about this faulty construction and collapsed fire boxes on Units 4 and 5 until they were called to your attention on cross-examination, did you?

"A. Well, I recalled fire box trouble, and brick troubles, but I could not recall the numbers of the units.

"Q. Here is a report of June 2nd. What unit does that refer to that says, 'Collapsed fire box'?

"A. Unit 3 and Unit 4."

2013 DR. GEORGE GRANGER BROWN.

Direct Examination by Mr. Hall.

4183 Referring to the Dubbs patent in suit, page 1, line 81, for reference made to "a liberation of vapors" from the liquid oil in the C tubes, I will state how this phenomenon compares with (a) vapors passing from a vessel, as in a tea kettle; (b) segregation of vapors as, for example in the seltzer bottle; and (c) mere formation of vapor bubbles in a body of liquid by liberation of molecules.

4185 The phrase "liberation of vapors," as it appears in the Dubbs patent, page 1, line 81, does not mean the separation of the vapors and their passing off as from a teakettle, nor does it mean the segregation of vapors from a liquid with the vapors passing on and leaving the liquid behind, nor does it mean the
4186 liberation of individual molecules so as to form bubbles of vapor within the liquid. It means just what it says, the liberation of vapors or the liberation or

freeing of bubbles of vapor entrained in a liquid phase, so that these bubbles may coalesce to form a continuous vapor phase.

4187 As I understand the Dubbs patent, there might be liberation of vapors, even though some liquid might be carried entrained in the vapors. There might be liberation of the vapors to form this continuous vapor phase, whether or not there is any liquid present either as a separate solid phase below the vapor or as entrained liquid within the vapor phase, provided the vapor is present as the external or continuous phase. The vapor is then liberated from the liquid and we have vaporization in the language of Dubbs.

4187 2014 It would be possible to have liberation of vapors as referred to in the Dubbs patent where the oil passes through the cracking tubes such as disclosed in the Dubbs patent, and there heated to a cracking temperature and 99 per cent of the liquid converted to vapor.

There are, of course, a number of factors which determine the liberation of vapors. The composition
4188 and the condition of the material are of major importance, but for practical purposes in a furnace coil we may say that there will be liberation of vapors whenever the volume of the generated vapor exceeds a certain value times the volume of the liquid, and that value may be somewhere around 500 or 1000 to 1, regardless of the velocity of the material passing through the furnace tubes; and on the other hand there is a minimum velocity below which liberation will probably take place even when the volume of the generated vapors is relatively small compared to the volume of the liquid present in the tubes.

4190 Q. Now, as to the cracking tubes, what is the essential characteristic as to the conditions obtaining therein in order to obtain a successful operation?

4194 A. For successful operation of a vapor phase process it is necessary that either the charge to the tubes be of such a low boiling range material that it is converted to a dry vapor by the time it begins to crack actively in the tubes, or that the material be passed through a vapor liquid separating step prior to entering the cracking tubes and only the vapor freed from entrained liquid be introduced into the cracking tubes. That is necessary because if we

have vapor containing entrained liquid or non-volatilized liquid in the cracking tubes in the vapor phase process, these particles of entrained liquid
4194 2015 become heavier, more unsaturated and tend to stick to the heating tubes and rapidly go to coke with the result that the process cannot stay on-stream for any length of time.

There is in this type of operation, which is between the mixed phase in which the vapors are entrained in the liquid and the liquid external or continuous phase on the one hand, and on the other hand the successful vapor phase operation in which the ma-
4195 terial undergoing cracking is substantially a dry vapor, a place which we may classify as "no man's land" which is always an unsatisfactory operation; and the Dubbs patent specifically teaches that we must stay in the mixed phase region as distinguished from the vapor phase and we must not enter the no man's land region by allowing the liberation of these bubbles of vapor from the liquid in the cracking tubes. If liberation was allowed we would then get into the condition where the vapor is the continuous phase in the cracking tubes and the residual liquid might be present as an entrained liquid. Now somewhere, at some percentage of vapor generation where the volume of the vapor exceeds a certain ratio to the volume of the liquid, this liberation of the vapor will take place regardless of the velocity, and that is the point which we must avoid if we are keeping within the Dubbs patent.

4195 2016 The reason that if the material gets into this no man's land the process would not operate successfully is because the entrained liquid being the
4196 internal phase, these individual droplets of liquid present as fog or mist, do not have a mutual solvent action; they are not in contact with each other; and when one of these particles containing the high molecular weight unsaturated material strikes the tubes of the cracking furnace there is no solvent material accompanying it to keep it in solution and carry it on through the tubes; therefore it tends to remain on the heated tube and rapidly go to coke. If the vapor were a dry vapor there would be no such particles present, or if there was sufficient liquid present to maintain the liquid in the continuous or

external phase, the solvent action of the liquid would carry these carbon forming materials out with the foamy mass which is passing through the tubes.

4199 From my knowledge of this art the word "residue" has never been applied to a body of oil or the component of a body of oil that is made up of non-volatilized oil and vapors from which the vapors have not separated or liberated themselves.

The term "residue" is used to indicate the material left behind after an operation such as the separation between liquid and vapor in which the generated vapors have freed themselves from the non-volatilized liquid oil and the non-volatile liquid oil left behind after the liberation of the vapors is referred to as the "residue."

2017 The Following Questions and Answers Were Taken Under Equity Rule 46.

4204 Mr. Hall. Q. Mr. Smith starting at page 3161 of the record, testified: "In defendant's vapor separator 4205 there is a foamy or frothy mass of liquid extending for a number of feet up into the separator. This is brought about by the high velocity of the stream of material entering the vapor separator which enters very close to the bottom of the separator, and this serves to agitate and stir up this small amount of liquid in there into this foamy mass.

"Now if 'vaporization' includes the separating step, or if 'vaporization' is the separating step, that takes place up in the vapor separator some distance from the bottom, and the residue, however, is drawn off from the bottom very near where the stream enters the separator.

"Now if vaporization does not take place until you get up here in the upper portion of the separator, above the foam or froth, then it seems to me that you would necessarily conclude that residue is withdrawn before separation because the residue is withdrawn from the bottom very near the inlet. Now that does not make sense to me but that it what I am led to if I include the separating step as a necessary part 4206 of the vaporization or if I say that vaporization is the separating step."

Now do you agree with Mr. Smith's conclusion

which he has reached from the facts he has stated; and if you do not, will you give your reasons?

4206 2018 A. No. It is true that the "vaporization," meaning the liberation of vapors to form a continuous vapor phase, takes place in the upper part of the vapor separator in defendant's operation, this vaporization or vapor space exists in defendant's operation above the stream which is the stream of liquid which is removed from the bottom of the vapor separator after the vapor has been liberated or has freed itself from entrainment within this liquid stream. In so far as the liquid residue is removed
4207 from the vapor separator prior to the liberation of the vapors, to that extent the efficiency of the vapor separator is impaired because it would include with the residue some of the reflux condensate and also the final product which is desired in the pressure distillate.

End Testimony Under the Rule.

Q. At pages 3254 and 3255 of the record Mr. Smith was asked whether a velocity of ¾ of a foot per second in the operation of the process of the Dubbs patent would be sufficient velocity to prevent segregation of vapors from the liquid, and in answering that it was not, he based his answer on his experience and observation, which he gave as follows:

"I have often observed visually something which I think is comparable for comparative purposes, and that is, in the operation of distilling crude oil where the light gasoline from the crude oil is running out of a 4-inch pipe into one of these lock boxes where
4207 2019 you can see the stream, the crude that I have in
4208 mind, which I have observed many times, contained enough highly volatile constituents that some of these constituents were not condensed, so that the stream coming out of this 4-inch pipe into the lock box was a mixed stream of liquid and vapor, and that stream flowing out of that 4-inch pipe at a velocity in excess of 3 feet per second was perfectly separated in the sense of having a liquid flowing along the bottom of the pipe and the uncondensed vapor flowing along the top of the pipe."

He also gave as a part of his experience, as follows: "In my experience with the Jenkins crack-

ing operation I have a much better basis for determining whether or not the vapor would separate from the liquid at specific velocities."

And he described the Jenkins set-up as illustrated in DX 777, and said: "The still was composed of three drums, an upper drum or longitudinal drum which was six feet in diameter and approximately 35 or 40 feet in length. Then there were two transverse drums located below the upper longitudinal drum. These were also six feet in diameter and were connected into the upper drum by sluiceways.
4209 2020 The transverse drums served as headers for a bank of tubes connected in parallel. And this bank of tubes was located inside of a furnace so that they could be heated.

"The structure of the still is quite similar to that of a conventional water tube boiler.

"The oil which was subjected to cracking filled the tubes, the two transverse drums, the sluiceways, and approximately half filled the upper longitudinal drum. This oil was circulated down through the rear sluiceway, the longer sluiceway, into the lower transverse drum and up through the bank of tubes into the upper transverse drum, and up into the longitudinal drum through the sluiceway where it flowed back to the rear sluiceway once more and down into the lower transverse drum.

"This circulation was brought about by a regular ship's propeller rotating in this rear sluiceway so that it circulated the oil through this cycle at a rapid velocity. The velocity through the tubes was approximately 10 feet per second. The velocity of flow of the oil in the longitudinal drum carrying
4210 the oil from the front sluiceway back to the rear sluiceway was in excess of 4 feet per second."

4213 Q. Will you please state whether either of these two operations is comparable to that which occurs in the operation of the process of the Dubbs patent as you have explained.

Mr. Thiess: Just a minute. In connection with this question I would like to ask the witness if he has had any experience with the Jenkins operation.

The Witness: No.

4214 Mr. Hall: Q. Will you answer?

2021 A. No, and my reasons are as follows:

4214 The flow in the large drum of the Jenkins still is in a vessel which is designed for the purpose of drawing off vapors from the upper space and returning the liquid from the bottom; it is an unheated vessel and it is not comparable at all to the conditions in the B tubes of the Dubbs patent, in so far as indicating velocities at which the foam might break so as to form a continuous vapor phase.

I will now make a comparison as to the operation of which there is gasoline or light product running down a pipe into and through a lock box, as one finds on an ordinary still.

4215 The conditions in the line leading to a lock box which I have seen, are also entirely different from the conditions existing in the B tubes of Dubbs and

4215 2022 is not a sound basis for determining a minimum velocity below which the foam would break in the B tubes of Dubbs.

4217 I agree with the statement that pressure used in a cracking operation serves different purposes, depending on the type of cracking operation whether it is a liquid phase or mixed phase or vapor phase.

In a vapor phase cracking operation it serves simply the function of increasing the density of the vapor, thereby increasing the capacity of the plant. In a mixed phase operation it serves at least two distinct purposes, one is to increase the relative quantity of liquid present and also to increase the density of the material, thereby having a dual effect of determining the proportion of liquid in the mixed

4218 phase and the density of the material. It also has an effect, which is perhaps dependent in part upon these two, of decreasing the tendency of the vapors to liberate themselves from the liquid. In a strictly liquid phase operation in which there is no vapor present the pressure would serve the sole function of keeping the material in the liquid phase.

If you mean by liquid phase operation one such as Burton or Burton and Clark, that last answer would be modified.

The Burton or Burton and Clark operation is not strictly a liquid phase because there are the two phases present, liquid and vapor. There, of course,

we have the same effect substantially as we would have in the mixed phase.

4218 2023 In a process as disclosed in a Dubbs patent in suit as I have described that process, there is a difference between charging a cracked residue from a previous run as a fresh feed and recycling the residue from a cracking operation.

The last operation is, of course, wholly outside of 4219 the Dubbs teaching. If we were to charge to a cracking operation, such as Dubbs, a residue from another cracking operation such as an operation in which gas oil may be cracked, the residue which constitutes the fresh feed for the Dubbs operation would pass through the heating tubes once, and the high molecular weight unsaturated carbon forming materials would be exposed to the cracking temperature in the cracking tubes B only for the length of time required for this residue to pass once through the cracking tubes. They would then be separated in the vapor separator or corresponding C tubes and withdrawn from the cycle.

Now if the residue, instead of being withdrawn from the cycle after the passage through the cracking tubes B, were to be returned to the entrance end of the cracking tube, these high molecular weight unsaturated carbon forming materials would go around and around through the cracking coils and be exposed to the cracking temperature for a very long time, and ultimately would inevitably go to form coke and deposit on the cracking surface and cause interruption of the continuous operation, because it would be im- 4220 possible to control the extent to which this residue was exposed to the high temperature in the 4220 2024 cracking coils unless all of the residue from the vapor liquid separating step was removed each time the material discharged from the cracking tubes.

I might add to that, that coke formation is really the end product of a chain of reactions which take place in this high molecular weight material, and that it takes time for it to actually form coke.

4222 One may not take the fact that a clean gas oil stock may be cracked without admixture with reflux to a greater extent without forming or depositing carbon than one can with the same fresh stock mixed with reflux in a once through operation, as

evidence of the fact that the reflux of a Dubbs operation, taking gas oil as the charge, does not have a solvent action in the cracking tubes. In fact, this very statement could be used to prove the opposite,
4227 for the reason that it is well known that the reflux condensate from a cracking operation having the same boiling range as a virgin uncracked gas oil used as the fresh feed, will crack approximately one-half as fast, let us say, as the virgin gas oil. If therefore we mix the virgin gas oil with two parts of reflux and crack the mixture in a once through operation
4228 to the extent of 30 per cent conversion, it is necessary to heat this mixture of virgin gas oil and reflux to a higher temperature or hold it at a cracking temperature for a longer time to produce that 30 per cent conversion than would be the case with virgin gas oil alone. In fact, if we assume that reflux cracks one-half as fast as virgin gas oil it can be
4228 2025 shown that the virgin gas oil is cracked to an extent of 45 per cent conversion and the reflux to 22½ per cent in order to produce 30 per cent conversion on the once through basis with a mixture of gas oil with two parts of reflux. Therefore that observation might be used just as well to show that the presence of the reflux enabled the operator to crack virgin gas oil to an extent of 45 per cent, which would be utterly impossible without the reflux being present.

4229 I will briefly state the process which I find in the British patent to Percy Haddan granted as a communication from George L. Benton, Titusville, Pennsylvania, No. 1922 of 1887, which is DX 787.

4230 This discloses an operation of a once through nature in which the oil to be treated is heated in the coil B under pressure, and the pressure is released by the valves, g, as the oil enters the chamber C, which chamber may be under pressure of one atmosphere or which may be exhausted to any lower pressure as desired, as stated in the complete specification, which is page 2, line 23.

And in the chamber C a rapid evaporation of the heated hydrocarbons is effected.

The invention is intended to produce lighter hydrocarbons from the refuse of petroleum oils, tar oils and other heavy mineral oils and a refining crude petroleum.

It might appear perhaps that this operation was intended as a cracking operation, but in my opinion he intended primarily simple continuous distilla-
4230 2026 tion. The apparatus is operable as a distillation operation, but if it is intended to maintain the temperature of the oil in chamber C the same as the temperature leaving the coil B, and if it is in-
4231 tended to keep a cracking temperature in coil B, that means a cracking temperature in the chamber C, and in that case the operation becomes very unsatisfactory because the cracked residue will be exposed to the hottest part of the furnace and the operation is really inoperable as a cracking operation. There is no specific teaching in the patent that he intended to use it as a cracking operation simply that he wishes to produce lighter hydrocarbons from other materials which might be obtained by simply distilling the lighter ends out of the other materials.

In any case it is simply a once through operation showing no recycling and no returning of reflux or anything of that nature.

I will now discuss the patents of Atwood 24,448 of May 15, 1860; Merrill reissue 7096, March 15, 1870; Dewar and Redwood 419,931, January 21, 1890; and Burton 1,049,667, January 7, 1913.

These four patents are all batch operations conducted in a heated shell still or similar vessel. The
4232 Atwood patent is operated at atmospheric pressure, and is a batch operation in which the still is charged and then run down by heating under atmospheric pressure.

The Merrill patent is a very similar operation. The interesting thing about the Merrill patent is that it describes in the second column of the first page,
4232 2027 the method of operating which is characteristic of all such batch operations. The fires are reduced under the still by damping and the stream of oil flowing from the condenser is greatly lessened, the process being so conducted that the heavy oil remaining in the still is lifted in vapors and again condensed in the still and falls back to be again and again vaporized and condensed, which is the operation necessary to supply the time required for the cracking which is conducted in the shell still.

In both of these, Atwood and Merrill, the operation

is conducted under atmospheric pressure and the cracking could be only to produce relatively heavy
4233 oil, such as the kerosene of that time.

The Dewar and Redwood patent is similarly a batch operation conducted in a fired retort or shell still, the significant difference being that in this operation the pressure is applied to the distillation by means of an extraneous gas such as nitrogen, air, or carbon dioxide or soemthing of that nature, but the operation is again a batch operation in which the material is charged to the still and it is distilled off at a slow rate..

The Burton patent discloses the elementary features of the Burton process and is again a batch operation in which the still is charged with, in this case, a selected gas oil, and the still is run down slowly under pressure to produce a cracked product.

4233 2028 In the Atwood, Merrill, and Dewar and Redwood operations there is no particular disclosure as to the kind of stock used, nor particularly as to the product produced.

The Burton operation was aimed at the production
4234 of gasoline and it was found that it was necessary to charge the still with a selected gas oil in order to operate successfully for the production of gasoline by this shell still batch distillation under pressure.

In none of these patents is there any teaching of a continuous operation with the return of reflux to the heating tubes, the withdrawal of residue, or of the condition in any heating tubes.

I cannot see any similarity in any of these patents to the Dubbs and Egloff in suit.

I suppose you might say that Burton has one feature in common, he is going to produce gasoline. There is really no similarity at all between these operations and the continuous operations of the patents in suit or the defendant's operations.

4235 I will now briefly describe and compare the following patents with the patents in suit and the accused patents. Edwards patent 1,170,884 (DX 785); Smith patent 1,239,423 (DX 786); and the Trumble patent 1,281,884 (DX 527).

All of these three patents, the Edwards, Smith and Trumble, show heating of the oil under treatment in tubes, the circulation of the oil under treatment

through the tubes and into a drum or other vapor liquid separating device and the recirculation of residue from this vapor liquid separating step back through the same tubes in which it was produced.

4235 2029 The Edwards and the Trumble are definitely continuous operations in that the feed is fed in continuously and a mixture of residue and reflux is continuously removed.

4236 In the Smith patent there is no teaching of continuous withdrawal of any residue, nor any continuous feed—think I am right on that—therefore the operation being a batch operation in which residue is circulated through the heating coils 17 as shown in the figure.

It is a continuous circulation of the residue through the heating coils. The statement is made, page 2, line 20, or line 17:

"An outlet pipe 25 for residuum leads from the lower end of the back header 16, and is normally closed by a valve 26."

which indicates that residuum is normally not drawn through valve 26, but in line 59 of page 2 it is stated that:

"As the suspended carbon accumulates, a portion of the liquid contents of boiler is withdrawn at intervals, for instance every thirty minutes through the residuum outlet 25 to the filter 30 where it is passed through fuller's earth, spent bone char, or product of similar nature and thereby made free from carbon.

Then it goes right back into still 13, through pump 11 in connection with the charging of the still through pump 11.

4237 Smith states on page 2, line 62, that the residuum is withdrawn and will go through the filters at intervals of about every 30 minutes.

4238 Valve 26 is normally closed but is opened at intervals of 30 minutes to withdraw a small part of liquid through filters 30. It remains open for

4238 2030 a short length of time. He does not state how long. I suppose it will be a minute or something of that nature. During the period valve 26 is open and some residue is passing through pipe 25, residue would be circulating continuously through coil 17.

The Edwards patent and the Trumble are both con-

4239 tinuous in that they have continuous feed and con-

tinuous draw-off. In the Edwards patent we find a series of cycles with the residue from each cycle being circulated back through the same cycle along with the fresh feed and reflux condensate, and the feed for the second cycle being composed of the residue from the first cycle; but in each one of the cycles the residue is circulated around and around with the fresh feed and the reflux condensate, and in so going around it passes through the heating tubes.

In tracing the path of the material in Figure 4 from the drum 8 around the cycle the charge would enter in Figure 4 at the lower left hand part marked 23, and
4240 with that charge through the same line is introduced the reflux or the condensate from the aerial condenser. So we have entering at 23 the fresh charge with reflux. And this material, this feed and reflux circulates up through the heating coils 1, into the header which I think is marked 20 and back down through lines marked 17 and 15, returning back.
4240 2031 through 15 directly to the heating tubes 1 and returning down through line 17 to the drum at the bottom which is No. 10, I believe; and then through line 16 into the heating coils 1. There is a small overflow from this circulation that passes from the first cycle through the hole 18 in the baffle 9 into the next cycle which operates in the same way,
4241 the feed coming from the first chamber through the hole 18 in baffle 9 into the second chamber and then circulating down through the pipe 17 to the header 10, and up through 16 into some separte tubes numbered 1 and back to the drum 8.

So in this cycle we also have the circulation of reflux, also the circulation of residue continuously through lines 17 and 15, and the heating coils 1. The residue from this cycle is withdrawn through another hole 18 in that baffle 9 into the third cycle, and similarly into the fourth or last one which is not shown. And the liquid residue from the fourth cycle is withdrawn through pipe 24 which dips down towards the bottom of the drum 7 as shown in Figure 3, to remove the liquid residue left from the operation. So that is a continuous operation with circulation of residue through each one of the four cycles and each one of the four cycles being fed by the residue from the previous cycle.

Referring to Figure 3 of the Edwards patent, nu-
4242 meral 18 represents the hole in the baffle 9 which is described on page 2, line 100:

"The connection between the drum compartments may be formed by openings 18 and 19 through the diaphragms near but somewhat above the bottoms in order to guard against their becoming choked by deposits."

4242 2032 In other words, there is a deposition of coke and other deposits in these drums, and these holes are placed above the bottom so as to prevent their being closed off by these deposits, the 8 is drum and 20 is the vapor space.

4243 As to the condition of the oil in drum 8 I think there would be a change in the composition of that oil as it flows from the first cycle into the second, into the third, and into the fourth as it is receiving continuing treatment throughout the flow. How much difference in composition there would be, I don't know.

In reference to the character of the material passing through the heating tube 1, it consists of the same
4244 material which is in that section of drum 8 or the drum 10; that is, in the first section it consists of fresh feed and reflux condensate and the residue which returns through lines 17 or 15. And in the second cycle it will consist of the feed which enters that from the first cycle, plus the residue from the second cycle; and the same for the third.

With respect to the material that passes from the drum 8 to and through the tubes 1 in the last section of the setup, or in the right hand section of Figures 4 and 5 the material is of the same composition as the material withdrawn through line 24.

4245 2033 In Trumble, if we refer to Figure 2, I think it is the simplest, the charge is introduced from pump 8 from the line which goes directly into the furnace, it passes through the tubes 1 in the furnace, and into the vapor separator 2. The vapors pass off through the horizontal lines into the pipe 45 and into the vessels 4, where they are subjected to reflux condensation, the reflux passing down into the horizontal line which is marked 68 and returns to the settling chamber 3. The residue from the bottom of the vapor separating step in the separator 2 is also fed to the settler 3 and in settler 3 we have a mixture of reflux

condensate and residue and that mixture passes through line 40, pump 6, line 41 to join the fresh feed which is pumped in by pump 8. Part of this mixture of reflux and residue is withdrawn through the line 44 and the pump 9, from the cycle.

So that here we have again cycling through the cracking tubes a mixture of reflux and residue of the same composition substantially as is removed from the bottom of the settling tank 3, so that the material which is circulated through the system is the same composition as the residue which is removed.

4249 Referring to the Ellis patent, (DX 804). This process is for making gasoline from heavier oil, such as kerosene, as stated on page 1, lines 9, 10 and 11.

It is a vapor phase process as stated on page 1, beginning about line 41:.

4249 2034 "This element may consist of a series of tubes placed in a furnace and adapted to be heated to a temperature of 400 to 600 degrees Centigrade or so"—

That corresponds to about 750 to 1,112 degrees Fahrenheit—

"—while the heavier oil passes through in the form of a vapor and is subjected to thermal decomposition during such travel."

He also intends to inject steam with the material being treated, as stated at the bottom of that column.

"Into the decomposer may be admitted along with the oil or oil vapors a quantity of steam so as to provide 20 to 50 per cent of water more or less."

He also wants to place catalytic material inside the decomposing tubes, page 1, second column, line 57:

"In the decomposing tubes I preferably place catalytic material."

The digester as shown in the figure is a continuation of the tubes in the sense that the reaction continues in the digester, as stated at the bottom of the second column, page 1, the last paragraph beginning about line 97.

"The decomposition products contain unstable constituents which, in the digester, react with the gases present and particularly hydrogen, or with each other or by polymerization, to produce more stable compounds in substantial molecular equilibrium. From

the digester the vapors may go to a dephlegmator or fractionating column."

4251 The operation being clearly a vapor phase operation as shown in the apparatus and as disclosed being a once through operation using as a charge, kerosene,

4251 2035 He believes he is going to recover some unconverted kerosene from some point in the dephlegmator 10 shown in Figure 3, as stated on page 2.

The dephlegmator is designated by 10 in Figure 3 and is described, beginning at the bottom of page 1 where I was reading:

"From the digester the vapors may go to a dephlegmator or fractionating column which preferably is of a type used in the rectification of alcohol and the like"—

Which would probably mean a bubble cap column or something of that nature,—

"—and the like in place of the ordinary coarse dephlegmator used in the present day rectification of oil. In the dephlegmator or fractionating column the heavy oil is condensed and if desired a dephlegmator may be arranged to yield as fractions a gas oil and unconverted kerosene especially if the latter is employed as the raw material. Preferably, however, the kerosene is separated from the heavier oils and the former returned to the decomposing tubes while the latter which is preferably separated as a fraction similar to gas oil, is collected and suitable disposition made thereof."

The rest of the description deals with the desulphurizer through which the vapors from the top of the fractionating column pass and the treatment they receive therein.

The operation is limited to a kerosene charge as stated in the patent, and is a vapor phase operation. No means are disclosed for cycling or returning any of the reflux to the treating coils and the operation in the dephlegmator is the reverse of the operations which do occur in the C tubes of Dubbs or

in the vapor separator of defendant, in that

4252 2036 there is no further vapor generation and no liberation of vapors from the stream leaving the cracking coils after they leave the cracking coils and enter this dephlegmator. In the dephlegmator

the action is solely one of condensing which is the opposite of vapor generation.

4253 In Ellis I do not find a separator interposed between the cracking tubes and the fractionating column in which cracking is continued or in which cracking occurs and from which residue is withdrawn, as is employed both in the Dubbs process and in the accused process.

There is no means disclosed in this patent for continuously recycling hot reflux and mixing it with fresh feed to form a combined feed which is fed to the heating coils.

I understand the apparatus and process which is disclosed in the Hall patent 1,175,910. The drawing that is shown me is a photostat reproduction of the

4254 drawing with the addition of quotations from the patent disclosure.

I will now describe this Hall patent and the process which is practiced in the apparatus and compare it with the Dubbs process and the accused process.

The apparatus consists of a charging pump 1 which charges the material to be treated through the line 6 and the preheating coil 2 in the upper part of the furnace.

In the heating coil 2 material is to be vaporized

4255 and is treated to a cracking temperature in the vapor state in the coils 4 which are the vapor phase cracking coils in the patent.

4255 2037 As the material leaves coils 4 in the state of gases and vapors, it passes into the line 7 through valve 8 where the pressure is reduced to approximately 10 pounds. It then enters the bottom of the first air cooled dephlegmator, which is either 9 or 10, wherein some of the material is condensed from the vapors and the uncondensed materials pass over as a vapor from the top of the dephlegmator at a temperature of about 617° F; and then these vapors pass down into the bottom of the second dephlegmator in which further condensation takes place, and the uncondensed vapors pass off from the top of the second dephlegmator at a temperature of about 356 degrees Fahrenheit.

These vapors which may still carry some mist pass over into the separator where this entrainment is supposed to separate out and return through the

line 16-A, and the vapors pass on through the line leaving the side of the separator to the compressor
4256 17 where the vapors containing the gasoline are subjected to compression, and thence through the tanks or condensers 19 and 20 and the receiver 21.

It is a once through operation, a vapor phase cracking, and Hall contemplates the use of almost any petroleum material as a charge. He states, page 1, line 87:

"Cracking an oil—(which may be crude, 'gas', fuel, lamp or almost any distillate that in itself has a range of boiling temperatures that would not permit its use as a fuel in the ordinary automobile engine)—"

And then more specifically, on page 2, line 50:

4256 2038 "In the practice of this process I start with a crude oil or a distillate which may be a 'gas oil' of about 0.860 specific gravity"—

that corresponds to about 33 degrees Baume or A. P. I.

—"or a fuel oil of say 0.950 specific gravity—

which corresponds to an A. P. I. gravity of 17.5 degrees.

Continuing, "—or a low grade lamp oil of about 0.82 specific gravity."

Which would be a kerosene of about 41 degrees A. P. I.

4257 "In fact the process is adapted to almost any mineral oil and with very slight modifications of operation."

Indicating that he is teaching the use of almost any mineral oil, either topped crude, crude oil, gas oil distillate or kerosene as the charging material.

In actual operation this plant could be successful only when using a charge such as kerosene because, as I have stated before, in a vapor phase operation of this kind where there is no separating step between the vaporizing tubes and the cracking tubes, it is essential that the charged material be of such a low boiling range that it will vaporize completely before it gets into the cracking tubes or is subjected to a cracking temperature, and that condition could exist in this operation only when charging a volatile material closely approximating the kerosene.

The cracked material leaving the vapor phase cracking coils 4 will carry with it a suspension of tar and vapor phase cracked residue unless the liquid charge is so volatile and is exposed to the crack-
4258 2039 ing temperature for a limited time so that this cracked residue does not form as droplets of heavy liquid in the stream.

Unless the initial charge is so volatile and the time to which it is exposed to the cracking temperature is limited so that the heavy tar does not form as particles of liquid which constitute a heavy mist or fog and which is extremely difficult to separate.

Evidently that was the condition which was experienced by Hall, because he stated on page 2, beginning about line 113:

"Carbon is thrown out in large quantities by the expansion of the gases and collects on the filling material in this and the succeeding dephlegmator."

Referring to the first dephlegmator and the second dephlegmator described in the apparatus. And if the carbon is deposited in those two dephlegmators as described, it is clear that there is a suspension of a mist or fog of heavy residual tarry matter which
4259 deposits the material in these dephlegmators, and is not washed out by simple condensation and is also carried over from the top of the second dephlegmator and is deposited in part in the separator, which is a device to eliminate or reduce entrainment.

The statements that clearly indicate it is a vapor phase operations are found on page 2, beginning line 68, where it is stated:

"The temperature of the gases and vapors inclosed in the tubes may be of somewhat lower temperature than that existing at the exterior of the tube."

4259 2040 He is there referring to the nest of tubes 4 and states that in these tubes there are gases and vapors.

And further on page 2, line 96, it is stated:

"From coil 4 the gases and cracked oil in the state of vapor pass in the direction of the arrow through pipe 7 which is fitted with a valve 8."

The statement is made that the light residue—this is page 3, line 2, referring to the light residue:

4260 "This residue is usually of a gravity of about 0.880."

—that corresponds to about 29 degrees A. P. I., "—and is used as raw material for a second run through the cracking coil 4."

Which indicates that he thought at least this material collected as a light residue might be run as the charge material in a second run of this equipment. It is not quite clear when he uses the phrase "as is used as raw material" whether or not he might have in mind that this material might receive some further treatment before it is run again through the unit, or whether it might be run as is. If it were to be used in this state as collected from the bottom of the dephlegmator under the conditions as disclosed by Hall it would be unsuitable material for charging to this unit as it would contain these tarry materials which he describes as depositing as carbon in this dephlegmator, and even if it did not contain these tarry matters or vapor phase cracked residue it would have such a boiling range as indicated by the temperature specified by Hall for the top tem-
4261 2041 perature of the first dephlegmator, that it would not be of sufficient volatility to form dry vapors by the time it had passed through the preheating coil 2 and entered the vapor phase cracking coils 4. So that in any case this light residue is an unsatisfactory material as a charge for a run on this apparatus, unless he means by the phrase "raw material" that it may be subjected to a distillation or some other treatment, in which case these tarry matters and heavy ends contained in that material could be left behind as a residue and the distillate used as a charge having somewhat the same characteristics as kerosene.

Referring to the last paragraph of the second column on page 2 of this patent, the temperatures given as 325 degrees C., which would be 617 degrees F., and 180 degrees C., which would be 350 degrees F; are the temperatures indicated at the top of the two dephlegmators, respectively.

4262 These temperatures indicate that the boiling range at least as to its upper limit of the material that would be discharged through line 15.

In the Hall patent I do not find any part which corresponds to the vaporizing chamber in which cracking and vapor generation occurs, which vapor-

izing chamber both in the Dubbs process and in the accused process, is located between the heating tubes and the fractionating column. Nor is there any part that performs a like function.

4262 2042 I do not find disclosed in this patent any means for continuously recycling hot reflux and it with fresh feed to form a combined feed for the heating coil. (The drawing which was omitted to 4263 the witness in connection with the Hall patent is admitted in the evidence as PX 836 and will be marked "as interpreted by the witness.")

I will now refer to the four Pielsticker patents which have been placed in evidence by defendant. British patent 1706 of 1882; British patent 6466 of 1890; British patent 1308 of 1891; and United States patent 477,153 of 1892; and I will first describe the apparatus and process disclosed in the British patent 1706 of 1882 (DX 789).

The apparatus is shown in the figure and consists of a metal coil E, which is stated to be, by preference, of copper. This is page 1, line 27:

4264 "by preference of copper say about 1-1/2 inch diameter and not less than from 50 to 60 feet long is connected with the Injector"—

That is the part marked "injector" at the front end,—

"and enters a horizontal retort G"—

The opposite end of the coil,—

"of copper or iron of say about 24 inches wide by 20 inches in height and from 12 to 15 feet long and divided by partitions in such a way that steam and vapors introduced at the outlet of the coil are obliged to circulate forward and backwards inside the retort. The inside of the retort is by preference filled with coarse pieces of coke or brick, in order to present a larger heating surface and to retard the passage of oil et cetera and the steam."

4264 2043 From the discharge side of the retort the material undergoing treatment passes out as a vapor into the condenser shown. And it states, page 1, line 34:

"At the back of the retort is a door H for cleaning and the retort has an outlet over the top and connected with a condenser."

The operation which Pielsticker had in mind to be conducted in this equipment, cover a wide range. It is stated in the first paragraph of the patent specification:

4265 "My invention relates to an improved method for the continuous distillation, boiling, saponification, and acidification of Fats, Oils, Glycerine, Rosins and hydro-carbons; and approved apparatus in connection therewith."

I imagine he means "improved" and not "approved", but that is what it says.

The only temperatures given in the patent are found on the second page numbered 5 of the specification, line 35:

"the temperature of the steam coil and retort, boiler or other receptacle, being maintained at about 200 Centigrade."

That is when he is carrying on the action described above.

That paragraph deals with—

"When the fats or oils to be operated upon for the production of fatty acids and glycerine are of animal or vegetable origin and are to be treated by the saponification process,"

and so on.

4265 2044 So that is the saponification operation in which he gives a temperature of about 200
4266 degrees Centigrade which is about 392 degrees Fahrenheit.

4267 The other temperature is given at the bottom of page 5:

"The temperature of the steam and of the coil need not exceed 180 degrees Centigrade."

This was apparently when he was manufacturing soap by this operation. And at the last page under the claims he describes a number of different operations, the first one is:

"The continuous distillation of fats, oils, glycerine, rosins, and hydrocarbons."

The second one, which is the only one which suggests any possible cracking operation, is on page 6, line 17:

"Secondly; the continuous production of illuminating and heating gas by forcing an intimate mixture

of steam and hydrocarbons through a coil and retort,
4268 the latter filled with coke in a state of incandescence, as specified."

Which is an operation evidently intended for the production of what might be called carbureted water gas, which is also mentioned beginning at the bottom of the first page, line 50:

"When the production of illuminating gas from hydrocarbon oils is intended, the temperature of the coil or retort is raised sufficiently high to produce permanent gases and to cause the decomposition of the steam by the latter coming in contact with the incandescent coke inside the retort. In addition to the condenser the usual gas purifiers will in this case be attached."

4268 2045 And at that time there was a good deal of interest in gas for city lighting and heating, and so on.

And the other operations described on the last page numbered 6, line 20:

"Thirdly: The continuous boiling of linseed oil,"—line 24,—

And "Fourthly: The continuous saponification and acidification of fats and oil for the production
4268 2046 of fatty acids and glycerine,"

and "Fifthly," line 34, "The continuous saponi-
4269 fication of fats and oils for the production of soap," and lastly is the apparatus.

I will now discuss the Pielsticker patent, British patent No. 6466 of 1890.

In this patent under the provisional specification he recites some of the difficulties he had with the previous apparatus we have just been describing. And beginning line 24,—there is confusion here between the new and the old, he says:

"The oil to be distilled is contained in a tank, in which is heated by means of a steam coil. From this tank the oil is forced by means of a pump, or by means of a steam injector, or otherwise, into a coil made of iron and placed in a heating furnace."

Now the next sentence clearly refers to the old coil where he was having difficulty.

"The coil is contained in an iron cylinder, which latter is filled with a metal or a salt of known melting point, so that the coil and the oil passing through

the latter can assume the same temperature as the bath of molten metal or salt surrounding the coil."

The next sentence refers to the improvement which
4270 he is covering in this 1890 patent, the improvement in the coil which he had previously described:

"In preference I make use of a coil which consists of a number of iron pipes, say 10 feet long and one inch (more or less) in diameter, the ends of which are open, and the whole of the pipes cast into
4270 2047 a solid block of iron. The ends of the pipes are closed by means of an iron cover, which is provided with channels so that the pipes form one continuous coil which cover can be easily removed and the pipes be occasionally cleared of the carbon deposited inside from the heated oil, by simply forcing an iron rod through the length of each pipe forming the coil."

The complete specification, which is a little more definite in not confusing the old coil with the new
4271 one, which begins on page 2, describes his invention in the second paragraph under the complete specification, beginning line 20:

"My invention relates to improvements in the distillation of hydrocarbon and other oils by means of which not only the operation of distillation is conducted in a continuous manner but also a lighter oil of one uniform gravity is obtained as the product of such distillation than the heavier gravity of the raw material subjected to distillation."

Now, keep in mind that at this time the ordinary distillation of hydrocarbon oil was a batch operation and in a batch operation the distillate produced is of continually changing gravity, when the still first goes on stream we get a very light product and as the distillation is continued the character of the distillate changes continuously, and there really were no continuous operations.

If we operate a still continuously it means that the composition of the charge and the composition in the still and the composition of the distillate and all of the streams remain constant. And this paragraph recites that he is going to carry on the distillation
4272 in a continuous manner and thereby produce a
4272 2048 distillate, that is a lighter oil of one uniform

gravity, rather than producing distillates of changing gravity.

4273 Referring to that part of the specification that I just discussed, in my opinion the language clearly describes a continuous simple distillation.

Then he again refers to the difficulty he had with the earlier coil, beginning in the paragraph line 31: "in employing this apparatus",—

That is the earlier one,—

"it was found that it was difficult to so regulate the temperature of the coil that all the oil at once assumed vapor form on entering the retort, while at other times the coil became so superheated that a portion of the oil became converted into permanent gas."

Which recites the difficulties he had with the prior coil and indicates that when it was operating improperly he got some decomposition into permanent gas and he had generally unsatisfactory operations with the coil.

And then line 46, he describes the coil which he is now going to use, in substantially the same language

4274 which I have previously read in the provisional specification.

He said:

"It will be seen that I now make use of a coil A which is formed of a number of iron pipes, say 10 feet long and say an inch and a half more or less, in diameter, the ends of which are open and the whole of the pipes embedded or inserted into a solid block of iron or refractory material B provided with longitudinal channels, through their entire length into which the pipes fit."

4274 2049 And he again refers to the cover at the end of the tubes which can be removed and the pipes occasionally cleared of the carbon deposited inside from the heated oil by simply forcing an iron rod through the length of the pipe.

As to the medium used for supplying the heat for the heat of the oil in patent 6466.

In this furnace is clearly disclosed a grate and the fuel used was coal, evidently a hand fired grate furnace, the grate bars are clearly shown as is the fire door and the ash pit underneath. In such an operation it is extremely difficult and actually impossible

4273 to control the temperature in the firebox at anywhere near uniform conditions, so that he had a great deal of difficulty in maintaining his coil at uniform temperatures but he found by putting his coil in these blocks of cast iron or of refractory material that this iron or material surrounding the coils would operate somewhat as a flywheel, absorbing part of the heat when the firing was very intense and giving up some heat to the coil when the firing was very low.

The use of iron or refractory means that he could not be contemplating a very high temperature in these coils if he is going to surround them with refractory material. That would have a great deal of resistance for the heat in flowing from the furnace into the coil itself.

He also describes on the third page, which is the last page of the specification, in the paragraph beginning line 6:

4275 2050 "I have found that by passing the oil through the coil with great velocity I in a great measure
4276 prevent the deposition of carbon or heavy matter which would soon choke up the coil. I now find it preferable to attain this object by graduating the diameter of the pipes A forming the coil, for instance if the entire length of the coil is two hundred feet, I construct the first fifty feet of two-inch pipes, the second fifty feet of one and a half inch pipes and the last hundred feet of one-inch pipes. I may however decrease the diameter of the coil only towards or at the inlet D into the retort."

Only the upper corner of the retort is shown in Figure 3 of the drawing. It is clearly a retort of different construction than he had in his previous patent but apparently all he is claiming in this patent is the heating tubes and he is apparently not concerned with the construction of the retort.

The cause of the deposition of carbon or heavy matter in the tubes referred to in the patent, is that he is operating first of all on a great many types of material carrying on chemical reactions where he has alkalies and acids and then under those condi-
4277 tions it is to be expected that with the evaporation of the oils and the water contained with the alkali there would be left behind salts, alkalies, things of that kind, which would deposit on the tubes and

thereby cause choking of the coils. The salt would of course hold with it some of the fats and oils which would become overheated due to the fact that the salt acts as an insulating means and the tube and the salt would both become baked on the tube and take on a dark or carbon appearance.

4277 2051 In addition to that, the operation of the coil being irregular as described in the later patent, when he shuts down, if he maintained the fire in the furnace after he shuts off the circulation of the oil any residual material left in the coil while the fires are in the furnace would, of course, bake down to more or less coke. So that this carbon or heavy material which soon chokes up the coil may be composed largely of salts or acids that he is using, or it may be something which is left behind after the plant is shut down, or it might be anything that
4278 might deposit as solid from the material that he is treating. It might be dirt in the oil possibly or salt in the oil if he is treating an oil which contains salt and salt water. That is a common experience in the coils even at the present day. If the oil is not treated to remove the water and the salt water before it is introduced to the topping furnace, why, that topping furnace will coke up, they say, due to the deposit of the salt from the crude.

My understanding of the function of the steam jet inside of the retort mentioned in the sentence commencing line 16 of page 3 is as follows:

A steam jet inside the retort may assist in drawing the vapors more quickly into the condenser which means that the pressure in the retort is atmospheric pressure and that there is no extra pressure avail-
4279 able to force the vapors from the retort into the condenser, and in order to get these vapors out of the retort quickly he applies this action of the steam jet which may create a slight vacuum on the
4279 2052 retort.

The next paragraph describes the operation conducted when he wishes to produce permanent gas and light oils, which is a cracking operation. He states, beginning line 19:

"When it is intended to produce still lighter gravity oils or even permanent gas, for the production of which the temperature of the coil and the retort has

to be kept higher and the distillation inside the retort conducted more slowly or retarded by means of baffle plates fitted inside the retort, a valve G may be placed between the outlet F of the retort and the condenser as shown in Figure 3."

The operation described here in which the distillation inside the retort is conducted more slowly is the same type of operation described for the batch still cracking such as was disclosed or described in the Merrill patent. In order to carry on a cracking action in a heated shell still, time must be provided
4280 for the material to undergo decomposition as the temperature that can be used is, of course, limited. If the temperature is too high everything would distill out of the retort, and cracking was conducted at about this period in batch stills to produce kerosene or light gravity oils accompanied with some gas; and the operation described here is exactly the same. The distillation inside the retort conducted more slowly, which indicates that he is operating the retort equivalent to a batch cracking still, using the coil as a preheating coil.

The retort would be heated with the coal fire or similar to that used with the coil. If the size
4280 2053 of the retort was approximately that disclosed in the earlier patent, it would have about the same exposed surface to the gases in the firebox as the tubes of the furnace, and considering the retarding effect of the refractory or iron around the coil, it would seem that the heat input into the retort would be about the equal of perhaps more than the heat input into the coils.

4281 The drawing (PX 837) shown me is a photostat of the drawing shown in the American patent in which Figure 1 and Figure 11 have been connected in the manner described in the patent, and to this photostatic drawing I have added comments which indicate the operation of this apparatus as the patent teaches me to operate it.

4282 These two patents, British 1308 of 1891, and U. S. patent 477,153, disclose the same apparatus and in
4283 general describes the same operation.

Pielsticker again recites the difficulties he had with the old retort used or disclosed in his patent of 1882, and again points out the advantages of the type of

coil we have just been describing. However, he discloses in these patents the construction of the retort and has modified his operations from those which were described in the 1890 patent.

Referring to the British patent first, No. 1308 of 1891, we gain a better idea of its operation than we can from the earlier patent.

4283 2054 Beginning line 13:

"The oil to be distilled is contained in a tank A, in which it is heated by means of a steam coil B, or otherwise. From this tank the oil is forced by means of a pump C, or otherwise, into a coil D which is formed of a number of iron pipes, embedded or
4284 inserted into a solid block of iron or refractory material E closed by covers F as described and claimed in my Specification No. 6466 of 1890.

"Between the force pump C and the inlet of the coil D, a steam connection H, is provided for the purpose of emptying the oil contained in the coil D at the end of the operation by a steam blast into a retort I into which the other end of the coil D leads; otherwise when the pumping is stopped the oil remaining in the coil D would speedily become carbonized and choke the coil."

It says in the specification, in the drawing here as taken from the American patent, that seems to be K. I thought these letters were all the same, it does not give the letters in the American patent,—

"A steam connection H,"—

In the drawing of the British patent is is clearly marked H and corresponds to the marking K in the American Pielsticker patent. It is then marked H in Figure 1 of the British patent and corresponds to the marking K of the American patent.

4285 This is the operation I described briefly a few moments ago, that when he shuts down his plant
4285 2055 he has a coal fire in the furnace and a mass of hot cast iron or refractory surrounding the coils D and it is impossible for him to cool that iron or to cool his furnace quickly, and the practice that he has followed is to shut off the oil from pump C and then try to blow the oil out of the coils D by means of this steam connection H. Of course, that is not going to clean those coils perfectly of oil and if the steam blast is not applied immediately there will be

considerable oil left behind in the coil after the plant is shut down but the heat is still in the furnace and the coils are surrounded by the cast iron which, of course, would augment or make very probable, if not certain, the deposition of coke in those coils when the plant is shut down.

The connection between the coil D and the retort I may be fitted with an expansion joint, as stated in
4826 the specification, and the retort I is provided with a number of baffle plates—I am afraid I have got confusion here by using the letters that are found in the British patent just marked. I perhaps better refer to the drawing of the British as long as I have completed this and then put the two together.

Referring to the drawings of the British patent, which are Figures 1 and 9.

"The retort I is provided with a number of baffle plates K,"—

In the specification, shown as K in Figure 4 of the British patent,—

4286 2056 "causing the oil vapors to take a lengthened passage through the retort, before they can enter the condenser U."

Which is up here in Figure 2.

The passage of the vapors would be as they enter the retort, to pass under the first baffle and be brought into contact with the liquid at the bottom of the retort; then the vapors are passed over the second baffle
4287 while the liquid passes under the second baffle through the space marked L. Then the vapors would be forced to pass under the third baffle and contact with the oil, and so on, through the retort until they pass under the last baffle in contact with the oil and up into the dome P. The same flow and the same construction is shown in the various drawings.

It states:

"A passage L is left in the lower part of the baffle plates in order to obtain the flow of the tar or residuum to the draw-off cock."

"Nearly at the lower end of the cover is fitted a valve N, for the removal of the tar or residue during the operation of distilling, a steam inlet O being connected with the tar outlet, in order to blow steam when the tar outlet is opened, which not only assists in the removal of the thick tar or the residue but

more particularly prevents air from entering the retort, which air would form a dangerously explosive mixture with the highly heated oil gases inside the retort."

Which is a similar use of the steam to that which he has described in the earlier patent as an aid in getting material out of the retort, but in this case he points out particularly that the use of this steam would prevent air from running back into the
4288 2057 retort and thereby forming an explosive mixture, clearly teaching atmospheric or even somewhat less than atmospheric pressure in the retort while he is discharging this tar. If the pressure of the retort were above atmospheric there would, of course, be no danger of any air running back in through valve N when withdrawing the residue from the distillation.

Continuing from the specification:

"A dome P and gooseneck Q connects the retort with a condenser.

Then he says:

"The dome P may be enlarged at its base forming a sphere, and may be provided at its lower end inside with a cup shaped projection T, into which any oil collects which may condense in the dome P and from which it may be returned into the retort I or into the supply tank A"—

Which is right back here,—

"through the pipe P'. This dome may be provided with a number of baffle plates S, which force the vapors to come in contact with the inner surface of the dome P, where the heavier portion of them are caused to condense and return to the more heated surface of the patent, are reduced in gravity and finally distill over and condense in the condenser."

4289 The dome is shown in all of the assembly drawings in both the British and the American patents as embedded in the brickwork of the furnace, and as shown in the assembly drawings can have only one function, that of tending to reduce or eliminate entrainment of particles of liquid suspended in the vapors leaving this retort.

4289 2058 The dome shown in Figure 3, which he says may be enlarged at its base forming a sphere, would be placed on these retorts in the same position

as the dome shown in the assembly drawings and would have the same function, that is, to reduce or eliminate the entrained liquid which may be carried out of the retort with the vapors.

The dome shown in Figure 3 having a longer surface over which the vapors must pass, would be more effective as an entrainment separator than would be the smaller dome shown in the assembly drawing, but it would have that same function, and having that function it would make no difference what happened to the material which collected at the bottom of the
4290 dome, returned to the retort or returned to tank 9, just so it got back into the distilling system and be subjected to redistillation.

The word "condensed" is used and has been used to indicate the coalescence of particles of liquid in fog or mist in much the same way as we may say fog condenses on a window or windshield of a car, and we will find that same language used in some other patents in the same way.

There would, of course, be a small conversion of vapors to liquid in the small dome P as shown in the assembly drawing and also in the dome Figure 3, because the upper plate of the dome P shown in the assembly drawing is exposed to the air and the upper part of the dome shown in Figure 3 would be
4290 2059 exposed to the air, but this condensation would be very limited in extent, probably amounting to two or three per cent of the total through-put, and in the construction shown in Figure 3 would aid in eliminating the entrainment as in that construction the vapors are brought into contact with the outer surface of the dome in their passage around the ends of the baffle plates S.

4291 The last paragraph on page 2 of the British patent, states:

"The condenser may either be an ordinary coil or a surface condenser, the first bend of which reaches into a vessel U nearly to the bottom of the latter, in which part of the vapors condense; the uncondensed portion being led by the second bend Q' from the top of the first vessel U to the bottom of the second vessel U' and so on through a series of condensing vessels, which are all provided with drawoff cocks V, in which

number of graduated specific gravities, heavier at the beginning of the series and lighter towards the end of the series."

Which indicates a distillation operation if he is operating on crude oil which might produce a fairly heavy distillate in the first tank U, a lighter distillate in U' and a light oil such as kerosene in the third condenser.

He says:

"Or instead of this arrangement, the products of distillation as they pass over from the retort I may be fractionally separated into a number of oils of graduated specific gravities by connecting the heating coil with a column still W,"—

Which is shown in Figure 8 of the British patent,—

4291 2060 "which may be similar to that used in the distillation of benzol, the body of which column still I also divide by baffle plates X and a drawoff cock Y for the tar or residue with steam ejector Z."

The baffle plates in the fractionating device shown in Figure 8 would eliminate entrainment and if reflux were brought down the column, they would to a limited extent, act in fractionating the vapors that would pass off, but primarily to eliminate the entrained liquid that may come over with the vapor.

Now when that is used as to whether Pielsticker proposes also to eliminate the retort I there is a little confusion in the language because he says:

"the products of distillation as they pass over from the retort I may be fractionally separated into a number of oils of graduated specific gravities",—

And then he says:

"by connecting the heating coil with a column still W",

4293 So if you follow his instruction as to what he is going to do, he is going to connect the column still W with the heating coil D, but the first part of the phrase says:

"The products of distillation as they pass over from the retort I",

So I suppose we might be allowed to put it either place but the language clearly says to put it at the end of retort D.

4294 2061 He says following, page 3, line 7:

"When it is intended to produce still lighter gravity oils, a valve R may be placed between the outlet of the retort I and the condenser U",

that is shown here in Figure 2,

"which may be kept open only so far as to create a certain pressure of the gases inside the retort, or such pressure may be created by means of a steam blast, introduced into the goose neck Q, and blowing in the opposite direction to the flow of vapors which distill over from the retort, or the goose neck Q may be contracted at some point to a much smaller diameter by valve R or otherwise",

The "otherwise" being shown at point R of Figure 3, where there is a contraction in this line, again keeping in mind that he has practically no control of his firing in these stills and if he wishes to control the quality of his distillate he will then have to resort either to an independent temperature control at the top of the dome P, which he does not have, or to some other means for controlling the quality of the vapors.

Now, if we are conducting a distillation at varying
4295 temperatures or when the temperature cannot be controlled we can, however, control the quality of the vapors by a slight control on the pressure, and as he has described here he has means for controlling the quality of the vapors leaving the retort by regulating or creating, as he says, a certain pressure of the gases inside the retort, by regulating the valve R, or by
4295 2062 the introduction of a steam blast in a direction opposite to the flow of the gases, which is another method of control than the control of the temperature. We can do it either by temperature or pressure.

The next paragraph describes a further application of the apparatus:

"In case the crude oil contains a considerable quantity of water,"

which as I have mentioned most crudes are delivered mixed with salt water, and unless this salt water is removed from the crude oil before it is sent to a pipe coil heater the salt from the water may deposit as a solid on the tubes of the heater and will cause choking of the tubular heater. Now evidently Pielsticker previously did not remove the salt water from the

crude. That was not practiced at that time. He
4296 states in the next paragraph:

"In case the crude oil contains a considerable quantity of water, the latter may be separated from the oil by placing the baffle plates horizontally into the retort,"

which is the way they have been placed at the bottom of the column still W shown in Figure 8,

"over which the oil and water flows, presenting in this manner a very extended surface, which is most conducive to rapid evaporation. The coil D and the retort I are kept at the temperature at which only the water distills off, while the oil pumped through the coil and retort is drawn off at the tar cock Y,"

and note the tar cock Y is the letter which is used at the bottom of the column still W of Figure 8,
4296 2063 not the letter which is used at the end of the horizontal retort of Figure 2,

"free from water and in a subsequent operation may be subjected to distillation."

So he is using this apparatus now for the removal of the water from the crude oil, which he evidently did not describe previously.

4297 In the next paragraph he again suggests a cracking operation.

4297 2064 The next paragraph, beginning line 21, suggests a cracking operation and he uses the same language to suggest this cracking operation as he has in the earlier patent.

I think that all of these operations that I have described are distillation operations, in which no cracking has been taught.

Now, the cracking operation is suggested, beginning line 21:

4298 "If the manufacture of permanent gas or of very light oil is intended, the retort I is directly connected with a second coil D' similar to the first one D; steam, which may previously have been superheated, being in preference simultaneously admitted with the oil vapors into the second coil D' by means of a steam injector H' provided for the purpose; the second coil may be kept under pressure by means of a valve G' or otherwise, and may be connected with expansion chamber or gas holder and condenser of well known construction."

The assembly of the apparatus as described in this paragraph is what is shown in the drawing, which is PX 837, which is the operation which he has described for the production of very light oils or permanent gas and is his cracking operation.

He has previously described that he puts the oil through the first coil D at a high velocity and then passes it through the retort shown as L in PX 837, and that the vapors are removed from the retort through the dome, and he now states that these vapors may be conducted into a second coil, which is D', for the purpose of producing permanent gas or very light oil, and the cracking operation in this patent is dis-
4299 closed as taking place in the coil D'.
4299 2065 He does not now describe the operation of cracking in the retort L, which he previously described as taking place by running the distillation very slowly. He is now putting the oil through the first coil D and the retort L to form the vapors, passing the vapors through an entrainment knockout dome and then cracking the vapors in the vapor phase in the coil D'.

The next paragraph describes other operations and he says it may be used for the distillation of other liquids besides hydrocarbons, for instance fats and oils in the separation of fatty acids and glycerine, and also for the continuous production of distilled water fram sea water, or the concentration of brine and alkaline solutions, and substantially the same language is used in the American patent except that some of the letters on the parts of the apparatus are different.

Referring to the American patent, page 2, commencing line 106, where it says:

"When it is intended to produce still lighter gravity
4300 oils, a valve B may be placed between the outlet of the retort L and the condenser U, which may be kept open only so far as to create a certain pressure of the gasses inside the retort, or such pressure may be created by means of a steam-blast introduced into the goose-neck S and blowing in the opposite direction to the flow of vapors which distill over from the retort,"

the pressure is measured, perhaps, in ounces rather

than in pounds, and I might say not more than one or two pounds at the outside.

What I believe is meant by this statement is if he wants to take off a distillate which is a lighter oil that
4301 has a higher A.P.I. gravity and has a lower boil-
4301 2066 ing range, that can be done without the change in his firing conditions by simply increasing the pressure a few pounds in the retort.

This expedient has been used in distillation and is used at the present time. Distillation is a function of pressure and temperature. Consequently if you increase the pressure to maintain the temperature, you will make a lighter distillate, more volatile distillate.

I do not find in any of the four Pielsticker patents a cracking process involving continuously recycling the product of a partial condensation, that reflux mixing with the fresh feed to form a combined feed to a
4302 cracking coil.

I know that it was common in shell still practice, practicing simple distillation to provide on the top of the still a dome from which the vapor line would lead because I have seen many of them. The function of the dome is the function that has always been given to those domes, which is to eliminate the entrainment or to reduce the entrainment. I will now point out in the British Pielsticker patent 1308 of 1891 and the American patent where the condenser is located and how it is designated:

In the British patent the condenser is referred to on page 3, line 8, condenser U, which is placed after the
4303 outlet of the retort I, and again at the bottom of the second page, line 54, "through a series of condensing vessels, which are provided with drawoff cocks V", again referring to the vessels U. I think later he has a reference to a condenser. Yes. In describing the cracking operation, page 3, line 27, the last
4303 2067 line of that paragraph, he says the outlet from the cail D' "may be connected with expansion chamber or gasholder and condenser of well known construction." I think those are the only references. I can find no reference in the British patent of the dome designated "P" as a condenser or partial condenser, nor do I find any such reference in the American Pielsticker patent. The presence of carbon in the coil D which is referred to in the Pielsticker pat-

ent does not necessarily indicate to me that cracking has occurred in coil D.

4304 I understand the process and apparatus disclosed in Greenstreet patent 1,740,691 (DX 809).

The drawing (PX 838) shown me was made under my direction and is a simplified drawing of the Greenstreet process showing simply one topping coil 15, one preheating coil 10, and one vapor phase cracking coil 2, and one digester 22, instead of the multiplicity of lines and digesters shown in the drawings in the patent.

4305 I will now state my understanding of the construction of the apparatus shown in this patent and the process which is taught there, and compare it with the process of the Dubbs and the accused process.

4305 2068 The apparatus of the patent may be best understood by referring to the simplified drawing, PX 838. The crude oil or the material used as a charging material is pumped from tank 11-A into the topping coils 15. From the outlet of the topping coils they unite with the outlets of the vapor phase cracking coils 2, and the mixed stream flows into the first digester 22. There are a series of digesters all

4306 of which are insulated and are maintained at a cracking temperature. Greenstreet makes quite a point of the fuel saving he is going to effect by maintaining the vapors in these digesters at a cracking temperature, thereby prolonging the time that the vapors are at a cracking temperature and increasing the conversion.

In the first digester 22 the residue that may be left from the crude oil or other material brought in with the topping coil, and whatever cracked residue may be condensed from the vapor coming out of the vapor phase cracking coil, is removed, so that we have a mixture through the line marked or indicated "cracked residue" in PX 838. So that we have leaving digester 22 only vapors flowing to the successive digesters through the line marked "vapor and gas at cracking temperature."

Greenstreet says he may, if desired, apply heat to some of these lines in order to maintain the temperature, but all of them are normally insulated so

4307 that there will be no heat loss.

4307 2069 In the digesters 24 through 30 cracking or conversion continues as an essential feature to the unusually large conversion referred to by Greenstreet, and in these digesters he says the heavy materials which in this case would be the polymerized product from the cracking operation, settle out or condense, which is using the word "condense" to mean the coalescence of these particles in the same sense we may use the word "condense" to indicate the settling out of entrainment. These particles settle out or condense into the line 42.

As the vapors pass into the last tank 31 they are subjected to cooling by a cooling coil, and the condensate, in the sense of material converted to liquid from the vapors passing through 31, is also introduced into line 42, where we have a mixture of these high molecular weight polymers and similar materials settling out of the vapor phase cracking in the digesters 24 to 30 with the condensate formed in the vessel 31. This mixture goes through a cooler and
4308 to tank 11, and is a mixture of what might be called vapor phase cracked residue or polymer product and condensate, which is wholly unsuitable for a vapor phase cracking operation as shown in Greenstreet, because Greenstreet here takes this material and puts it through preheating coil 10 at the outlet of which it is to be in vapor form and then tries to crack this oil vapor, if it could be converted to a vapor under those conditions, in the vapor phase
4308 2070 cracking coil 2, and the outlet of the coil 2 is then mixed with the crude oil charge, as I have described, and part of the vapors leaving the cracking coils 2 may be condensed in digester 22.

The only possible way to make a satisfactory vapor phase cracking operation when using a material as a feed which contains high boiling material is to put it through a vaporizing step prior to the cracking coil. In other words, the unvaporized material, the material that can not be vaporized before it gets into the cracking coils, must be separated from the material fed to the cracking coils if the material contains these high boiling materials, and in this
4309 case the material fed to the preheating coils and thence to the cracking coils will contain extremely

heavy material, which is the polymerized product settling out in these digesters 24 to 30.

These operations are clearly disclosed in the patent. The vapor phase condition is clearly stated on page 2, line 91:

"The oil is conducted from the storage tank 11", which is the tank from which the feed is drawn for the preheating coil 10 and the vapor phase cracking coil 2, "into the preheater coils 10 and is vaporized approximately upon leaving the preheater", leaving the preheating coils 10. "It is then conducted in vapor form and accompanied by steam through the cracking coils 2 where it is heated to a high temperature under pressure."

The continued cracking of the vapors in the
4309 2071 digesters is clearly taught and emphasized on page 2, beginning line 108:

"By the use of the process as above described, the heavier fractions, which are not transformed into lighter fractions in the cracking coil, due to the
4310 rapid velocity of the contents through the cracking coils, are converted into lighter fractions during the course of the vapors through the various digester tanks, so that upon leaving the digester tanks, an unusually large percentage of the coils is transformed into lighter hydrocarbons and due to the heat insulated passage through which they are conducted, the fuel consumption for heating the oil under treatment is greatly reduced and due to the prolonged exposure of the particles to a high temperature while under pressure, the unusually large conversion above mentioned is accomplished."

He states that these lines are insulated, the digester tanks are insulated, on page 1, line 75:

"The digester tanks 22 and all other parts of the pipe system and tanks are heat insulated by some suitable compound 23 in any well known manner." He also states he may heat the pipes if he wishes, on page 3, line 29:

"While the apparatus above described, shows no application of external heat, other than in the
4310 2072 furnace, it is to be understood that I may, nevertheless, add some heat to the piping system at suitable points, if desired."

The cracking of the vapors and the production of
4311 these high molecular weight polymers which occurs in the vapor line and particularly in the digesters 24 to 30 is an essential part of the operation as described by Greenstreet, because he says he is going to conserve fuel and get an unusually large conversion due to the cracking or conversion which takes place in this digester system.

That is the mode of operation actually claimed in claim 4 in the Greenstreet patent. In claim 4, beginning line 80, "all of said tanks being heat insulated to conserve the heat energy of the oil vapor and permit the additional cracking thereof."

The operation as it occurs in these digesters and the settling out from the vapor of the polymer is described at the bottom of page 1, beginning line 97, the lower right-hand corner:

4312 "Connected with the bottom of all of the digester tanks 24 to 31 inclusive is a header 42 in which the heavier ends settle out or condense."

4313 Mr. Hall: Q. Assuming that in the Greenstreet patent the material on its way to the high temperature cracking coils is given a preliminary heating for converting that material into vapor, but between the preliminary heating and the high temperature cracking coil there is not a separating step for separating out residue from the vapors, and such material contains the residue from the tanks 24 to 30 of the Greenstreet patent, and material cracking does occur in those tanks, would or would not that be an operative process?

4315 2073 The Witness: That would be inoperative.

Mr. Hall: Q. Can you state whether or not the vapor phase cracking which you state occurs in the digester tanks 24 to 30 of the Greenstreet patent would be accompanied by liquefaction of the heavy polymers which are formed?

4316 The Witness: Yes, at least a good part of them. It would be proper to refer to this liquefaction as condensation.

4317 I have considered the Alexander patent 1,407,619, February 21, 1922 (DX 806) and I confined most of my attention to Figures 5 and 8.

The drawing (PX 839) shown me was made under my direction and is a drawing of the modification of figure 8 as stated in the patent, where vaporizer 75 of figure 5 is incorporated in figure 8, and with comments indicating my interpretation of the conditions and the operation of this modified figure 8 of Alexander.

Referring to figure 8 of the patent, which includes the shell still 121, the operation is to vaporize material out of the oil in the shell still 121 and carry those vapors through line 122 at atmospheric pressure, or less, into the vapor phase cracking tubes 113, wherein the cracking takes place. From the bottom of the tubes 113 the vapors are led across to the bottom of the exchange tower 110. In the exchange tower they meet additional fresh oil brought
4318 2074 in through line 111 and pump 112, which is introduced in the top of the exchange tower. Coming in contact with this colder oil the hot vapors entering the bottom of the exchange tower undergo
4319 partial condensation, and at the bottom of the exchange tower is collected the heavy ends which are condensed out of the vapor phase cracked vapors entering the bottom of the exchange tower and also the unvaporized heavy ends from the crude oil or other material which may be charged in through line 111.

This residue is withdrawn through line 115, as described. The vapors pass overhead from the exchange tower 110 through the line 116 and constitute, as stated by Alexander, the kerosene, solar oil and gas oil from the crude which is introduced, meaning he is topping fairly deeply into the crude oil and these materials, along with the vapor phase cracked material which was not condensed in tower 110, enter the bottom of the dephlegmator 117.

In this dephlegmator these vapors undergo partial condensation and the more volatile material, including the gas and the pressure distillate, pass overhead through line 118, the condenser 119, and into the tank, which collects the final products.

4320 The condensate from the bottom of dephlegmator 117 is brought back to the shell until 121, along with some additional feed of oil, so as to constitute the

material supplied to the shell still 121 and from which the vapors are formed to supply the cracking tubes 113. As so described we are supplying vapors,
4320 2075 which, is properly prepared would be substantially free from entrained liquid, to the cracking tubes 113, and we have then a vapor phase operation supplying vapors to the cracking tubes 113 which could be operated in a reasonably satisfactory manner insofar as the keeping of the plant on stream is concerned, provided the cracking tubes and the other parts are properly designed.

I am asked if there is any part in this set-up of Figure 8 of Alexander that corresponds to the vapor chamber of the accused process or the vaporizing chamber of the Dubbs process.

The exchange tower 110 in Alexander includes heat exchange between the cracked vapors from the
4321 tubes 113 and the charging oil introduced from line 111, but the operation in that tower is the reverse, insofar as its treatment of the vapors from the cracking tubes 113 is concerned, as compared with the operation of the C tubes in Dubbs or the vapor separator in defendant, insofar as their treatment of the material coming from the cracking tubes is concerned. In both Dubbs tubes C and the vapor separator of defendant there is vapor generation and liberation from the stream coming from the cracking tubes B, or the cracking furnace, while in the Alexander operation there can be no further vapor generation or vapor liberation of the material coming from the cracking tubes 113, as that material is in the vapor state.

The opposite action takes place, the condensation of part of the vapors entering the tower.

The oil which is fed to the operation in figure 5 is brought in through line 76 and into this line is
4322 also introduced the condensate, which collects in the bottom of the dephlegmator from the pan 90.
4322 2076 That joins that same line 76. This mixture of condensate from the dephlegmator and the fresh feed is pumped up to the top of the exchange tower through line 78. The liquid residue which collects at the bottom of the exchange tower 79 is taken out from the pan at the bottom through pump

80 and pumped into the vaporizing coil 75 so that the feed for this vaporizing coil consists of the raw oil, the residue and the reflux condensate. The supposed vapors leaving coil 75 pass through line 81 into the cracking tubes 82, and the vapors leaving the cracking tubes 82 pass through line 84 into the bottom of the exchange tower, and there on in the same manner as I have described in figure 8.

The disclosure of figure 5 would clearly be inoperative because the residue, the reflux condensate and the fresh oil are all mixed together, sent into a pipe still vaporizer, with no possible opportunity for a vapor liquid separating step making it possible to supply the dry vapors to the cracking tubes 82.

4323 The reference to the pressure used in the operation of this apparatus is on page 2, beginning line 47:

"I operate at about atmospheric pressure; using no more pressure in any event than is necessary to produce movement of my vapors. It is even better not to use this much pressure, or indeed to use a slight degree of vacuum since the vapors can be moved by suction as readily as by pressure and a slight degree of vacuum promotes the volatilization of any liquid oil that may be present."

So the operation in the cracking tubes and throughout the rest of the equipment will be at atmospheric pressure or a little bit less, or possibly a little
4323 2077 bit more, but substantially atmospheric pressure or less.

4324 Referring to the statement in the patent: "The vaporizer shown in this view is a still similar to still 109 shown in Figure 7 but under some circumstances
4325 I may employ in lieu thereof such a special vaporizer as the element 75 of Figure 5", I find no statement in the patent as to what those circumstances might be.

You might interpret it perhaps as meaning the operations as shown in Figure 5 but there is no statement in the patent.

In this proposed set-up in which the vaporizer of Figure 5 would be substituted for the shell still, Dr. Reiman gave certain operating conditions for a typical run of the apparatus modified as there suggested, and those conditions were as follows: He

would take a 25 degree Baume, a topped crude, and have it from Mid-Continent source and Engler Distillation on the 65 per cent to be taken overhead. This gas oil having initial boiling point of 500 degrees F. and 700 degrees F. at 75 or 80 percent off, and an end point of 900 degrees F., and having a gravity of 28 degrees Baume; and he would operate it with the pressure of about 60 pounds at the inlet
4326 to the coil 75 and 10 to 30 pounds in the cracking tubes 113 and he proposes a cracking tube 113 having a diameter of 6 inches, having an internal diameter of 6 inches, and a length of 200 feet, and he said he would operate it with a through put of 500 barrels per day, 500 barrels of this topped crude. And he said a temperature of the vapor in the cracking tube would be 99 degrees F., and that the oil would
4326 2078 be completely vaporized in the vaporizing section at a temperature lower than 900 degrees F. and that the conversion per pass would be 15 to 20 percent of gasoline. Now with those operating conditions, can you visualize the operation of the set-up of Figure 8 of the Alexander patent, modified by the substitution of the vaporizer 75 for the shell 121?

A. Well, that would not operate in the sense of staying on stream for any length of time, because the material being supplied to the vaporizing coil 75 has a boiling range, as you have given me, of 500 to 900 degrees F. and it is impossible to operate a vapor phase cracking process with such a feed unless
4327 there is a vapor separating step prior to charging the vapor into the vapor phase cracking coils. And in the modified Figure 8, in which the vaporizing coil 75 is substituted for the shell still 121, there is no such vapor separating step, and that means that this operation could not continue on stream.

In order to stay on stream it is necessary that the charge or the feed going to the vaporizing coil be converted to dry vapor at a temperature below a cracking temperature and this material which has a boiling range from 500 to 900 even under atmospheric pressure would not be converted to dry vapor until after a cracking temperature is reached and, of course, with the 60 pounds at the coil entrance that

raises the temperature of conversion to vapor about 100 degrees so that the presence of pressure on the coil 75 would make this operation more difficult. Therefore coking would occur either in coil 75 if an effort were made to fire coil 75 so as to produce dry vapors, because we would then have liberation
4327 2079 of the vapors in coil 75 and the entrance into
4328 this condition which I have described as no man's land where we would have the deposition of coke on the tubes.

If on the other hand the temperature in coil 75 is not raised to a cracking temperature, then the stream passing through line 122 would not be dry vapors and we would have the same condition that I just described for coil 75 in the cracking coil 113 and cracking coil 113 would coke. So that operation is impossible in the sense of being able to stay on stream for any length of time.

If the coil 75 is made of very large tubes then there is a certain tolerance whereby it is possible to cover the inside of these tubes with coke and continue the operation for a short length of time. That has been a practice which was conducted some years ago in vapor phase operations. There we deliberately deposit coke in the vaporizing coil 75 and, depending upon the coke tolerance of those tubes,
4329 we might say, and limited by the coke that can be deposited on those tubes and still stay on stream, the operation can be conducted for a limited length of time.

The three-inch tubes given by Doctor Reiman for the size of the tubes in the vaporizing section would not be of adequate size to have any appreciable coke tolerance and that operation could not be conducted for more than, you might say, a few minutes really.

Referring to Figure 8 as is, one would get dry vapors there for passage through the coils 113 because Figure 8 as is, the use of the shell still or a battery of shell stills, as Alexander has described it, includes this vapor separating step, so that only vapors are delivered through line 12[illegible] Of course that
4329 2080 means there will be a residue left behind in shell still 121 from this vaporizing step con-
4330 ducted therein, but in that case it would be possible

to properly prepare the vapors to be supplied to the vapor phase cracking tubes 113.

If I assume that the modified still did work under conditions suggested by Doctor Reiman, it would not be possible to get anything like 15 to 20 percent of gasoline per pass with the throughput, the length of the tubes and the operating temperatures which Doctor Reiman gave. As to the order of conversion of gasoline, one would get, if we were to assume arbitrarily a two to one reflux ratio, the time of the vapors in the cracking tubes would be of the order of 11 or 12 seconds at 900 degrees F. which would correspond to, perhaps, two or three percent conversion per pass, instead of 15 to 20 percent as he stated.

The reflux ratio I just gave was arbitrary because
4331 with a cracking per pass of two to three percent making any appreciable yield, the reflux ratio would have to be much greater than that, and with a greater reflux ratio the time and temperature would be still less, so it would seem as though no commercial result could be obtained when sending 500 barrels of crude oil into that unit and topping out of it 65 percent on that throughput with the size of tubes and temperatures which were given.

4331 2081 I am familiar with the construction of the apparatus and the processes which are disclosed in the Biddison and Boyd patent 1,345,740, July 6, 1920 (DX 801). I have read this patent many times and studied it and I believe I am as familiar with it and understand it as well as anyone not possessed of clairvoyant powers could be.

The drawing (PX 840) shown me is a photostatic
4332 enlargement of Figure 1 of the patent. There are no comments of any kind added to this drawing.

I agree with the statement that there are three processes described in this patent, the first two of which circulate residue from a cracking operation through the cracking coils. I believe it is clearly a vapor phase cracking. The disclosure is incomplete and somewhat inadequate and contradictory in that respect, but the emphasis is placed on the idea of supplying large quantities of superheated gas which are prepared in the coil 1 in the furnace, and mixing

4333 these large quantities of superheated gas with the preheated oil and the mixture of superheated gas and oil undergo treatment in the cracking coils 2. The object of the use of the large quantities of superheated gas is to supply most of the heat required for the cracking operation so that only a small amount of heat need be put into the cracking tubes 2. The only statement we have as to the pressure involved and the proportion of these gases is given on page 2, beginning line 6:

4333 2082 "If the pressure in the cracking zone,—" That is coil 2—"is 100 pounds absolute, and the oil vapors constitute one per cent of the total vapors present, then the pressure of the oil vapors is one per cent of 100 pounds or one pound,"

So that he is operating in the cracking zone or coil 2 with a partial pressure of the hydrocarbons of one pound absolute, if we follow these instructions.

4334 One pound absolute means a vacuum of about 13½ pounds per square inch. The atmospheric pressure is approximately 14.6 pounds per square inch absolute, and gage pressure is the pressure measured above atmospheric pressure, so when we say we have 10 pounds pressure, ordinarily we say 10 pounds gage pressure, meaning we have 10 pounds per square inch pressure greater than atmospheric pressure, or an absolute pressure of about 24.6 pounds.

Now in this patent he has been careful to state these pressures are absolute pressures, so that one pound absolute means a pressure of about 1/15 of atmospheric pressure. He is operating with the pressure of the hydrocarbon vapors much less than atmospheric pressure.

So under those conditions of operation, it seems clear to me that it is a vapor phase operation because he is at a cracking temperature with a greatly reduced partial pressure on the hydrocarbon oil or the hydrocarbon vapors.

In effect Biddison and Boyd is operating at a cracking temperature and a very high vacuum, the low absolute pressure of one pound being equivalent to a high vacuum insofar as the oil vapors are concerned.

4335 2083 Assuming that his charge was gas oil and he operated under those conditions the oil would be in the vapor state in the cracking coils.

I will briefly describe the operation starting with the cracking coils and going to and through chamber 8, giving the conditions which would obtain in that chamber.

He uses chamber 8 in the first operation, which is the batch operation, as a source of his material being treated. In the other two operations which are
4336 continuous, that is operation 2 and operation 3, he says he maintains an oil level in tank 8.

Now the mixture of oil vapor with a large amount of gas leaves the cracking coil 2, passes through this carbon pot, 3, through line 7, into 8, and the gas and vapor pass on out through tank 8 through line 24. Throughout the entire course of that material from the cracking coil 2 until it leaves tank 8 there is no means of cooling. No means of cooling have been provided except the incidental cooling which might take place due to radiation to the atmosphere. So that under operations conducted continuously the temperature in the tank 8 will be high, probably well at a cracking temperature and not much less than the temperature of the gas and oil vapors leaving the cracking coil 2. Under those conditions little material, only an insignificant quantity would be deposited in tank 8, perhaps not more than the deposition of some of the entrained droplets of tar, and it would not be necessary to remove any significant quantity of material from the bottom of tank
4337 8 in order to maintain the oil level therein.

4337 2084 Then this mixture of gas and oil vapors passes over through line 24 into the hot condenser 25, where the material is cooled sufficiently so as to condense some of the hydrocarbon vapors, and this material would contain substantially all of the high boiling material which is in the hydrocarbon vapors coming out from the cracking coil 2, and passing through tank 8, except for the insignificant quantity which might be deposited in tank 8.

Then the uncondensed hydrocarbon vapors, along with the large quantity of gas, will pass out through the tank 26 through the line 28 into the condenser 29, where additional material will be condensed and will be collected in tank 31. The gases containing the gasoline vapors then pass up through 34 and through the absorber or scrubber 35.

The material which collects in the tank 31 may be withdrawn and sent to a storage or returned for further treatment as shown, and material which collects in tank 26 is sent back—is sent down to tank 18,
4338 and mixed with fresh oil introduced through line 40. And this mixture taken from tank 18 is picked up by pump 22 and sent to the preheater coil 6, to the cracking coil 2 by either one of the flow streams shown, either through line 43 to heat exchanger 16 through line 44 or around through line 23.

The statement is found at the bottom of the first page, line 108 that

"In our process only a portion of the oil in the cracking zone is in the vapor state."

Now that condition would probably develop after this plant got on stream because of the produc-
4338 2085 tion of heavy polymers which would pass out of tank 8 which is obviously at a cracking temperature, in the presence of this large amount of gas, so that when these heavy polymers are then again returned to the cracking coil 2, and again subjected to treatment at a cracking temperature in the presence of this large amount of gas, they would not be completely vaporized. And it is possible that this
4339 statement is true as given at the bottom of page 108, but he states that at the bottom of page 1, beginning line 108:

"These vapors from the oil are mixed with the superheated gas."

and so on through the operation.

4340 Assuming that the oil in tank 8, if the apparatus is on stream, is heated up to merely the temperature of the transfer line, the character of the material that would remain in this tank as residue would be an extremely heavy high boiling material because it would be the liquid residue left when the material is heated to a cracking temperature, and under a very low partial pressure, if we take the conditions as stated in the patent under a partial pressure of about one pound absolute.

I will give the ratio of gas to liquid in the crack-
4341 ing coil 2 on a volume basis, that is the volume occupied by the gas and vapors divided by the volume occupied by the small amount of liquid which might be left, say that there is 90 per cent of the oil con-

verted to vapor in the cracking coil 2, and that we are operating at 100 pounds pressure under the conditions as set forth in the patent at the top of page 2, the volume occupied by the gas and vapor would be approximately 16,000 times the volume occu-
4341 2086 pied by the liquid oil. If the oil is only 50 per cent converted to vapor under those conditions the ratio between the volume occupied by the gas and vapor to the volume of the liquid oil would be about 1700 to 1.

The ratio of vapor or gases to liquids in the heating tubes of defendant's operation varies, of course, from zero at the entrance end and up to the roof tubes, but at the outlet of that furnace it is stipulated that 95 per cent of the volume is occupied by vapor which gives the ratio of the volume occupied by the vapor to the liquid of 19 to 1.

4342 With reference to the third method of operation set forth in this patent, I do not find that uncontaminated reflux is returned with fresh feed to the cracking coil.

The reflux, I think you mean by that the material collected in tank 26, would contain not only the entrained particles of heavy tar which would be produced and is produced in such operations, but would also contain high boiling material condensed from the vapors as they pass through the hot condenser, and these high boiling materials would be extremely high due to the low partial pressure of the hydrocarbon vapors and these high boiling materials would be or are unsatisfactory materials to charge to a vapor phase cracking operation unless there be a vapor-liquid separating step between the preheater or vaporizing coil 6 and the cracking coil 2, which is not provided in this patent.

The valve designated 9 on line 10 leading from the
4343 bottom of the chamber 8 is mentioned only once in
4343 2087 the patent, page 3, line 23, where it is stated that valve 9 is closed along with some other valves while the system is being filled with oil preliminary to getting it on stream.

I can see no other specific function for this valve. As I understand, though, it has been given a function of trying to control the oil that is in tank 8, but as I see this operation with tank 8 at the cracking tem-

perature and these gases passing through tank 8, there will be no necessity of removing any oil from tank 8 to maintain the oil level therein, because if the operation starts with oil in tank 8 as soon as it gets on stream that high temperature of the gas and oil coming from the cracke. 2 will vaporize out from this oil a good part of the material and that the deposition of tar from the vapor phase operation will be very small,
4344 so that the level would be maintained in tank 8 without removing anything from it, and the valve 9 could therefore remain closed just as is indicated by the statement in the patent. That is for the continuous operation.

I find no suggestion in the patent for changing the valve 42 from the position in which it is shown on Figure 1 of the patent drawing. There is no suggestion anywhere in the patent that the position of that valve be changed, nor does there appear to be any need for it. I am speaking of this continuous operation No. 3.

As to the function of the part which is marked "tar still" in Figure 1 of the patent, the tar still is described on page 2, line 91;

4344 2088 "When, after considerable use the system accumulates some tarry matter, valve 20 may be closed and valve 42 opened. Then the oil from 8 passes to still 11. From 11 the distillate vapors pass," and so on.

And again on page 3, line 53:

"After the system has been in use for a considerable length of time, tarry matter accumulates to a slight extent, and this is removed as heretofore de-
4345 scribed."

So that the tar still is intended to distill this tarry matter which may accumulate in the tank 8, and in the first operation, the intermittent operation—the batch operation, rather, where the level of the oil is not maintained in tank 8, the tarry matter as it may accumulate in tank 8 might be removed by running into still 11 at intervals, as stated in the patent. But it seems to me that in the operation 2 and operation 3 where a level is maintained in tank 8, that that level would be maintained without withdrawing any material from the tank 8, and it would not be neces-

sary to use this tar still in order to maintain the level in tank 8.

The tar still is shown fired by the same type of flame as is used for the cracking still, which may be natural gas or other similar fuel from the drawing Figure 1. It is an externally fired shell still.

4346 I will state what the patent teaches in reference to the pressure that obtains in the still and the temperatures to which the oil therein is heated. The pressure, rather, in that still will be the same as the pressure in the tank 8 which will be the same as the pressure of the cracking coils, because, as he states, the

4346 2089 oil from tank 8 is run into the still 11 by closing the valve 20 and opening valve 42; and that means that the pressure in the tar still must be equal to the pressure in the line 10, otherwise the oil in line 10 would back up through line 14, through the tank 13, back through the heat exchanger, down through condenser 17 and into tank 8.

The exact method of handling this still and the way the oil level in tank 8 is maintained, are not clearly described but it is evident that the pressure in tar still must be equal to the pressure in the line 10. The temperature there, of course, must then be much greater than the temperature in tank 8, because

4347 in tank 8 the liquid is under this low partial pressure created by the use of the large quantity of gas, and it remains as a liquid. In the tar still 11 there is no partial pressure effect of the gas to aid in vaporization of the material in the tar still and it would be necessary to heat that material in the tar still to a higher temperature than exists in tank 8 in order to create any vapors or cause any distillation of the tar in still 11.

Q. Referring to the Biddison and Boyd patent, the Alexander patent with the vaporizer 75 substituted for the shell still, and to the Greenstreet patent, in your opinion what is the condition of the oil in the heating or cracking tubes as compared with the condition of the oil in the cracking tubes of the Dubbs process and the cracking tubes of the accused process?

A. In these three patents the condition in the heating and cracking tubes is that of separated or

4347 2090 liberated vapors from the liquid at a cracking temperature; while in the Dubbs patent and in the accused operation there is no liberation of the 4348 vapors in the heating or cracking tubes at any cracking temperature. That is the very difference which I have tried to point out in these vapor phase operations where the cracking tubes are not supplied with dry vapors. It is then necessary to reach a cracking temperature with the vapors liberated from the oil and with the oil present as entrained liquid which represents the condition of no man's land between the mixed phase cracking operations and the satisfactory vapor phase operation.

Referring again to the Biddison and Boyd patent, if the tar still was heated to a higher temperature than that which obtains in the tank 8 the tar still would form large quantities of coke and being heated under pressure, immediately get hot bottoms and the still would be subject to rapid ruptures if the distillation or the heating were continued. It would be very similar to trying to operate the Burton still at about the same pressure and at a higher temperature when charging the Burton still with a vapor 4349 phase cracked residue, or a mixture of oil containing such residue.

(Copy of the application for patent filed in the United States for Carbon P. Dubbs on January 27, 1917, serial number 144,979 and renewed December 14, 1921, serial number 522,397 admitted as PX 841.)

Mr. Thiess: I would like to ask Mr. Hall what the purpose is of these file wrappers that he is offering now.

Mr. Hall: Well, this is to show, this particular one that I am now going to offer and later describe, 4349 2091 shows that the invention of the patent in suit was reduced to practice, constructive reduction to practice by the party Dubbs at least as early as January 27, 1917.

4350 (Mr. Hall: I also offer in evidence a certified copy of the file wrapper of the application, PX 841, as PX 842; the purpose of this being, if your Honor please, to show that the case was pending in the Patent Office at the time that the Dubbs patent in suit was filed and, in consequence, that the Dubbs patent in suit is a proper continuation of this earlier application.

It is a certified copy of the actual record in the Patent Office.)

4353 The enlarged drawing (PX 843) shown me is the photostat of Figures 1 and 2 of this application, as the two drawings Figures 1 and 2 represent a single plant they have been shown on the two pages. The only changes made have been the lines connecting the parts which are not connected in Figures 1 and 2.

4355 Another drawing (PX 844) shown me was made under my direction and, as stated on the drawing, is a simplification of Figures 1 and 2 of the application we are discussing, using all five stills and omitting means for bypassing not used in this assembly. It is a clearer drawing with the parts more clearly labeled and therefore more easily understood because it is not confused by the bypassing parts which are included in the photostatic reproduction of the drawing PX 843.

I will describe this drawing in connection with the
4356 disclosure of the application. It is stated in the
4356 2092 application that any one of the heating coils, which are marked B, the stills which are marked A, the partial condensers which are marked I, or the vapor pumps J, may be by-passed so that we can use all five of the stills, or less of them, all five of the heating coils or a less number, and all five of the condensers I, or a less number, and so forth, and these means, these valves and by-passing lines which are included in the drawings in the application have been omitted in this drawing (PX 844) you have just shown me, for the reason that they would not be used. Those valves would be closed and those lines would not be used when operating all five of the heating coils and all five of the stills and all five of the condensers I, and all four of the pumps J. It is just to clarify that operation in which all five of the complete units are used.

4357 I will next describe the apparatus which is disclosed in the Dubbs application of January 27, 1917 and the processes which he teaches and which one may practice by the use of that apparatus.

The apparatus, as shown in PX 844, includes five stills A-1, A-2, A-3, A-4 and A-5, and the corresponding heating coils B-1, B-2, B-3, B-4 and B-5, and on top of each one of the stills a reflux condenser

I-1, I-2, I-3, I-4 and I-5, and four vapor pumps, for
4358 aiding in transporting the vapors from the tops of the refiux condensers back to the previous stills. For example, the vapors that pass up from the last still A-5 pass through the partial condenser I-5 and enter the line 13, then pass through the vapor pump J-4
4358 2093 and are introduced back into the bottom of the preceding still A-4. Correspondingly the vapors that pass up from still A-4 pass through the condenser I-4, through the line into the vapor pump J-3, and are introduced at the bottom of the next preceding still. Similarly by the use of J-2 into the bottom of the next preceding still, and by J-1 into the bottom of the first still. So that the vapors which are separated or liberated in these stills A-5, A-4, A-3 and A-2 are passed backward into the next preceding
4359 still while the liquid which is left as a residue in each one of the stills A-1, A-2, A-3 and A-4 is withdrawn from the top of that still and sent through the next succeeding heating coil.

For example, the liquid left as a residue in the still A-1 flows through this line connecting the upper left-hand part of A-1 with the heating coil B-2, and through the heating coil B-2 this liquid is heated and introduced into the bottom part of the next succeeding still A-2, and similarly the liquid residue which is left in A-2 passes through the next following heating coil B-3, into the bottom of A-3, and the liquid residue left in A-3 passes into the next heating coil B-4, into A-4, and so on, into A-5, and the liquid residue left in A-5 is withdrawn through the line shown, so that liquid is flowing continuously from the still A-1 toward the left, while the vapors are flowing continuously from the still A-1 toward the left, while the vapors are flowing continuously from the still A-5 backward toward the right into the next preceding still in each case.

4360 The vapors leaving the still A-1 pass up through the condenser I-1, through the pressure release
4360 2094 valve C, and then through the final condenser into the receiver N, and that constitutes the pressure distillate containing the desired product. And the gas is released from the top of the receiver N and the residue withdrawn from the still A-5 is the residue from the operation which is removed at

the opposite end. The feed to the apparatus is introduced at the pump K-1, through line 1, line 2, and passes up through the heat exchangers, where it receives heat from the various vapors rising from the different stills, passing through the condensers I-1, I-2, I-3, I-4 and I-5, by the connecting lines 2, and then through line 2 to the entrance end of the first heating coil B-1.

As to the purpose of the invention as set forth in this application, beginning on line 11 of the first page:

"The invention contemplates a method and apparatus whereby crude petroleum, petroleum distillates, petroleum residuum,"

that means the topped crude or the residue which is left from a distillation of petroleum,

"or other like material can be placed in the apparatus and a gasoline-like product produced. Other objects of the invention are: to provide a process in which the oil being treated is fractionally distilled and subjected to a cracking, breaking up, polymerization process to convert heavier hydrocarbons or like substances into lighter, and then such changed or converted oil fractionally distilled as one uninterrupted process,"

and then further is a more detailed explanation which involves the operation which I have already described.

It is stated at various places through the specification that any number of the stills, condensers and coils may be used.

4361 2095 On page 2, beginning line 20:

"Describing in detail the method with reference to the apparatus shown in the drawings: A-1, A-2, A-3, A-4, A-5, designate the stills or retorts, (any number of same may be used)"

and on page 3, line 18:

4362 "and should it be desired to by-pass the material to be treated around this reflux condenser, then valves 5 and 6 would be closed and valve 7 open, the oil traveling in this manner through or past reflux condenser I-2, I-3, I-4 and I-5."

The by-passing of the vapor pumps is described, page 4, line 29:

"Any vapor pump and the retort it is connected

therewith, can be by-passed by the closing of valve 15′ and opening valve 14."

And the by-passing of the heating coil is described on page 6, line 9:

"and it will be noted that the oil can be by-passed around any heating coil, suitable valves being provided for this."

So it is clear that we can by-pass any one or more of the heating coils, of the stills, the reflux condensers, or the vapor pumps.

As to the conditions of operation, it is stated on page 1, line 27 that each one of the succeeding stills from A-1 to A-5 operates at a higher temperature:

4363 "provide a method and apparatus in which a series of stills and chambers are employed and in which the hydrocarbons treated are subjected to progressively increasing temperatures; to provide a method and apparatus in which the vapor and gases are subjected to progressively decreasing temperatures,"

because the vapors and gases pass in the opposite direction to the oils,

"the vapors and gases being preferably allowed to percolate up through the various chambers and stills, advancing from those having the higher temperatures to those having the lower temperatures."

4363 2096 As to the effect of the gases discharged into the bottom of any one of these stills percolating up through the liquid in the still, it would make for a very efficient contacting of the vapors and gases in the still, so that you might say an equilibruim condition would be reached therein, and of course, it also decreases the density of the material in the still because it has these bubbles of gas and vapor passing up through the liquid, and it keeps the oil in each still thoroughly agitated so that the composition in the

4364 still is substantially uniform.

The effect upon the vapors themselves which pass up through the liquid is that as the vapors pass back through the succeeding stills and come in contact with the liquid oil at lower temperatures the vapors are rectified; that is, the high boiling materials are absorbed out of the vapors in these oil bodies and, correspondingly, the low boiling material is vaporized out of the oil in the oil bodies into the vapor and gas passing back counter-current to the liquid. So we

have then an operation which is substantially the same as that which is carried out in the modern rectifying columns in which the vapors pass from a zone of high temperature to a zone of low temperature, countercurrently, contacting oil or liquid flowing in the opposite direction from a zone of low temperature to a zone of high temperature.

4365 The reference on page 5, beginning line 3:

"The oil in each succeeding still is maintained at a higher temperature than that of the preceding still, and as the oil passes from the first to the last still, it will have been subjected to progressively increasing temperatures."

4365 2097 Now, the results obtained from this apparatus and operation are summarized at the bottom, beginning at the bottom of page 5, line 26:

"This novel method of treatment will tend to prevent any heavy vapors, or such vapors which have not been sufficiently treated, from passing to the condenser,"

that is the condenser M and M-1,

"since the step-down in temperature, as the vapors and gases pass through the various stills towards the condenser, will tend to condense any heavy vapors and cause them to be carried back with the residuum and again subjected to the higher temperature. Another material advantage of this method of treatment lies in the fact that the vapors and gases being stepped down in temperature by percolating through the liquid in the successive stills having lower tem-
4366 peratures, the heat units which are extracted in cooling the vapors and gases are transmitted to the liquid which is traveling in the reverse direction and is stepping up in temperature."

The operation is summarized on page 6, beginning line 16:

"From the above description it will be apparent that the raw material is first preheated by the heat units extracted in cooling the heated vapors and gases as they pass through the reflux condensers."

Those are the reflux condensers marked I in the top of the still.

"Second, that the heat units are extracted from the oil, gases and vapors generated in the heating

coils as same percolate up through the oil contained in the retorts."

And he states that the heat units which are extracted from the oil and the generated vapors leaving the heating coils, that the heating units are extracted from this material as the generated vapors per-
4366 2098 colate up through the succeeding still or retort.

"Third, that the material treated is progressively subjected to increasing temperatures while
4367 maintaining any desired pressure on the vapors and gases generated, and that the resultant vapors and gases are caused to travel in the reverse direction, that is, through progressively decreasing temperatures, while caused to percolate up through the liquid, so that the liquid, vapors and gases are present in the zones of reaction, and the vapors and gases progressively advance towards the still or through a proportion of the apparatus having a lower temperature.

"While I have shown and described a particular apparatus for carrying out my method, the latter is not limited to use with the particular apparatus shown and described. Also various changes in the details of construction and connections and operations of the apparatus can be made within the scope of my invention."

There are one or two other places I should like to read where I think he states the oil, along with the vapors generated—at page 3, line 26, he says:

"the oil along with the vapors generated after passing through the heating coils B-1, percolates up through the oil contained in the still A-1,"

which is another reference to the oil and the generated vapors in heating tubes.

4368 We find that statement again on page 4, line 8:

"and the gases and vapors generated in furnace B-2,"

which was later changed to the heating coil B-2,

"percolate up through the oil contained in the still."

and so on.

4370 2099 I will now give my understanding of what is said on page 4 of the application, lines 22 to 28:

"such vapors not being of sufficiently low boiling point, are condensed as they percolate up through the oil in retort A-1 and pass up through reflux condenser

I-1 and are subjected to a further treatment by overflowing to the next heating furnace and still by means of overflowing pipe Q-1 and this operation is followed throughout the entire apparatus."

This states that the vapors as they pass back into the preceding still undergo a partial condensation in the preceding still, and that the condensate formed from those vapors in the preceding still flows out through the line marked q in the specification, and
4371 are again returned to the heating coil connected with the still from which they were vaporized out.

Referring to the coils B-2, B-3, B-4 and B-5, the material discharged from these coils, consisting of oil and generated vapors, flows into the following stills, A-2, A-3, A-4 and A-5, respectively, in which stills liberation of the vapors takes place, the vapors
4372 passing up through the partial condenser on the top of each one of these stills, and the liquid which remains as a residue being withdrawn and sent to the next succeeding furnace or pipe heater.

Q. Would you please state whether or not according to the teachings of this patent the residue formed from the separation or liberation of the material discharged from any one of the coils B-2, B-3, B-4 and B-5 is ever recirculated through that coil?

A. It is not.

I will describe the circulation of the oil
4373 2100 through the coil and chamber.

Starting from the discharge of the coil B-4 the oil and the generated vapors discharged therefrom into the still A-4 undergo a vapor liberating action in A-4, the vapors pass up through the line R-4, the partial condenser I-4, through the pump J-3, and are introduced at the lower end of the still A-3.

In this still A-3 the high boiling materials in the vapor are condensed and absorbed in the liquid of lower temperatures in A-3, and these higher boiling materials which are condensed out of the vapors entering the bottom of A-3 from the still A-4 are then introduced through the line leading from the upper left-hand side of the retort A-3, back to the entrance end of the heating coil B-4, and that action will continue, so that the high boiling vapors liberated in A-4 and condensed in A-3 will cycle around through the heating coil B-4.

The liquid residue left from the vapor separating
4374 step in the still A-4 passes out through the line shown at the upper left-hand side of the still A-4, into the heating coil B-5, and does not get back to the heating coil B-4.

The material which is fed to the entrance end of coil B-4 (PX 844) is a combined feed because it is composed of the liquid discharged from B-3 into A-3, and the condensate formed from the vapors which are introduced into A-3 and which came from the still A-4.

4375 2101 The retorts A-1, A-2, A-3, A-4 and A-5 are unheated by any application of heat to their exterior surfaces.

Q. What were the processes which were in commercial use for taking gasoline as a primary product prior to the date of this application?

Mr. Thiess: If your Honor please, does this witness know this of his own knowledge?

The Witness: I know of Burton and the Burton-Clark operations.

Mr. Thiess: At the time that this application was filed?

The Witness: In 1916 and 1917, and I don't know of any other operations that were conducted commercially at that time.

Mr. Thiess: Do you know that of your own personal knowledge?

The Witness: Yes.

Mr. Thiess: Or is it a matter of reading the literature?

The Witness: No, I saw the operations at that time.

Mr. Hall: Now, if, as one skilled in the art, you were asked to run this application, this device of the Dubbs application, which is represented in PX 844, following the teachings of the application, and to make gasoline as set forth in the application and to get gasoline yields that would be at least comparable to those that were obtained by the Burton and Burton-Clark processes, can you tell us how you would run it, giving us particularly the oil temperatures at the various points and the throughputs and the yield?

4376 Mr. Thiess: Now, if your Honor please, I feel

that this application, if there is any disclosure, speaks for itself. The witness is now being asked to read into this application something that is extraneous, and I object to that.

4379 2102 The Court: All right, you may answer the question as I put it.

4380 (The record was read as follows: "The Court: Well, I think I will let him answer it but as I understand it he is simply to describe the manner of operation of this sort of still. It will simply be by way of illustration of how this still of this character would be operated, as I understand it.")

The Court: By a person who is skilled in the art.

4380 The Witness: At that time cracking operations to produce gasoline were operated at about 100 pounds pressure, and the charged material was usually a gas oil.

Mr. Hall: Q. May I just interrupt you for one thing? If you give any temperatures, or anything, 4381 at different points that may conveniently be marked on the drawing as you go along, will you mark it on that exhibit, Plaintiff's Exhibit 844, so we will have a permanent record of it?

Mr. Thiess: Now, if your Honor please, that is just the thing that I am objecting to. He is reading into this disclosure data that is not shown in the disclosure, and he is, as of today, taking the disclosure of this abandoned application, reading into it operating conditions and, as Mr. Hall just said, yields, et cetera. Now, I don't think that this witness is justified and should be called upon to read into that disclosure anything in the way of operating conditions. If they wish to carry back their 2103 date they must stand or fall on this disclosure, or call the man that did it.

Mr. Hall: The man that did it, his testimony couldn't add one iota to a disclosure that he has made in the Patent Office. This disclosure must stand for what it is to the man skilled in the art, and that has been set forth in Loom *vs.* Higgins, half a 4382 century ago, by the United States Supreme Court. All of these patents are addressed to the man skilled in the art, and the patent is what he sees in it.

The Court: He may testify as to the operation of a still of this character by a man skilled in the art

and as a man skilled in the art would have operated it at that time, not as one having the information that a skilled person would have today, but as conditions were at that time and as operations were conducted at that time.

Mr. Von Holst: He was not even in the art at that time, your Honor.

Mr. Hall: He was thoroughly familiar with the art at that time.

The Court: I assume an expert would know what the condition of the art was at that time.

4383 Mr. Neuman: The point we make, your Honor, is that they cannot by this method read into this application temperature and pressures and yields and charging stocks, and matters of that kind, which are not there.

The Court: Well, suppose that a person having just such an apparatus as this before him at that time would have known how to operate it, taking conditions as they were then, with the knowledge
2104 a man had then, if there were such operations at that time, and temperatures that should be used, can't he testify how it would have been operated at that time?

Mr. Thiess: No, your Honor.

Mr. Hall: Oh, he could.

Mr. Thiess: Just a minute. If the inventor had made that sketch and made this drawing and had that description, he would not be entitled to amend that disclosure and drawing one iota to carry back his date. He would have to testify that he made a disclosure to somebody else as to that other subject matter and be corroborated as to that disclosure before he could carry back that date.

4386 The Court: Mr. Hall's position seems to me the reasonable one. I shall admit the testimony. Of course, as I said about other matters of testimony, you may be able to argue me out of it in your briefs and show me I am wrong.

A. At that time the commercial cracking
4386 2105 operations were the Burton or the Burton-Clark operation, which was conducted at a pressure of about 100 pounds per square inch and with tem-
4387 peratures in the stills of about 730 to 750, and they

were taking off a pressure distillate which contained gasoline, and they were operating on gas oil.

Now, if we take this unit and operate on gas oil to make a pressure distillate of about 53 or 54 degrees A. P. I., that fixes the temperature which we would have to maintain at the top of the partial condenser I-1, which would be approximately 450 to 460 degrees F.

The stills used at that time were horizontal stills 8 feet in diameter by 30 feet long. They did not then use vertical stills.

They used stills of about the same dimensions and
4388 about the same construction. The Burton stills were fired. These stills are not fired, but I should presume at that time they would use stills of about the same dimensions and the same construction.

So we will use as the stills A-1, A-2, A-3, A-4 and A-5, vessels of about 8 feet in diameter by about 30 feet high, and the coils in the various furnaces would probably be about 4-inch coils—they were in use at that time—and there might be about 40 tubes in each one of those furnaces, all arranged in parallel, and the other equipment in proportion.

Now, charging gas oil to a unit of that size and of that construction, the capacity of this unit would
4388 2106 be about 500 barrels per day, and that gas oil would be about 33 gravity or so, 33 degrees A. P. I. gas oil.

4389 This gas oil would be fed through all of those partial condensers I-1, I-2, I-3, I-4 and I-5, and in passing through those condensers if it enters at about 60 degrees Fahrenheit, being cold gas oil from storage, it would leave the last partial condenser, which here act as heat exchangers, to preheat the gas oil, at a temperature, say, of about 280 degrees Fahrenheit.

4390 The partial condensers, being constructed of a size indicated by the scale shown in the drawing of the specification. When feeding 500 barrels per day of 33 gravity gas oil to this plant the temperature would be about 280 degrees Fahrenheit as it leaves the last heat exchanger and enters the first furnace B-1. As it leaves the first furnace B-1 the temperature would be about 400 degrees Fahrenheit.

The temperature in the still A-1 will be higher

than that due to the introduction of the hot gases from the next succeeding still, and the temperature of the vapors leaving the top of the still A-1 would be about 480 degrees Fahrenheit. The material leaving the second pipe heater B-2 would be at a temperature of about 550 degrees Fahrenheit, and similarly the temperature of the vapors leaving A-2 would be somewhat higher than that due to the heat brought back into this still by the vapors from the next succeeding still, and the temperature at the top of A-2 would be about 575.

That is the temperature at the top, say, of the still A-2.

4391 2107 The oil and generated vapors leaving the pipe heater B-3 would be at a temperature of about 600, and the top of the retort A-3 would be at a temperature of about 640.

Similarly the temperature of the material leaving the pipe heater B-4 would be about 705 degrees, 700 degrees, let us say, Fahrenheit, and the temperature at the top of the still A-4 would be about 710 degrees.

The temperature in the last still would be approximately the temperature that was in use at that time for cracking to produce gasoline, which was usually between 730 and 750—we will call that 740—at the top of the still A-5. And the temperature of the material, oil and generated vapors, leaving the pipe still B-5 would then be about 845, which I believe give the essential temperatures for the operation when charging about 500 barrels of 33 gravity gas oil per day and operating at about 100 pounds pressure on the apparatus and at the temperatures used at that time for the production of gasoline by cracking gas oil.

4392 The yields on this operation will be somewhere around 45 to 46 per cent by weight pressure distillate of about 53 to 54 gravity and the residue would be about 42 to 43 per cent of about 19 gravity and the charge would be 100 per cent of gas oil of about 33 degrees A. P. I.

4393 The pressure distillate would contain about 80 or 85 per cent, perhaps, of gasoline of the kind produced at that time, which would make it about 38 or 40 per cent by weight, say, 35 to 40 per cent by weight

on the charge of the gas oil. Everything is
4393 2108 based on the gas oil charge as 100 per cent.

Mr. Thiess: We move to strike all this testimony introducing these operating conditions into this disclosure, if your Honor please.

The Court: I think I will deny the motion. It may be that Mr. Hall will have quite a job in convincing me that I should give a great deal of weight to this testimony. I don't know. Wouldn't I have this to consider too: If the disclosure here is sufficient to warrant the issuance of a patent on this application, I suppose then that one skilled in the art could testify as to how it would be operated by a skilled operator.

Mr. Neuman: That is what we intend to argue, the fact that this was an unallowable application and abandoned and it can't constitute a reduction to practice.

The Court: If it wasn't sufficient I don't think I can be aided by the testimony of this witness. I will consider those things. As I say, I have very grave doubts as to the weight that it should have, but Mr. Hall may argue that in his brief.

4397 Another drawing (PX 845) which was shown me
4398 was prepared under my direction and represents the apparatus that is disclosed in the application we have been discussing, using only stills A-1, and A-5 and omitting those parts not used in this assembly.

It is my understanding that the Dubbs application teaches that one may use only the stills A-1 and A-5 as shown in the drawing (PX 845) which is submitted to me.

4399 I will describe what is shown by PX 845 and the foundation that I find for it in the Dubbs application.

4399 2109 Mr. Thiess: The objection goes to all of this. That is what I understood.

The Court: Yes.

Mr. Thiess: And the motion also?

The Court: And the motion also.

I have already read from the specification those parts, page 2, line 22, or rather beginning line 20, which states that any number of the stills A may be used; and page 3, line beginning 18, that the reflux condensers may be by-passed if so desired; and page 4, beginning line 29, that the vapor pump J may be

4400 by-passed or eliminated; and page 6, line 10, that oil may be by-passed around any heating coil.

So that he clearly teaches we may use any number of these stills, heating coils, reflux condensers and vapor pumps, one or more of each, up to five, all except the vapor pumps which are only four in number.

Mr. Hall: Q. Now, taking the setup of Exhibit 845 will you please state, as you did before, in connection with the five-still setup, how the man skilled in the art would run this two-still setup to make gasoline in quantities comparable to that which was done commercially by cracking operations in use just preceding the date or preceding the date of this Dubbs application?

The Court: The same objection?

Mr. Thiess: Yes.

The Court: What does this add to what you have
4401 already given?

Mr. Hall: Well, if your Honor please, it doesn't
4401 add much, but as we understand this application
4401 2110 it describes that one may use, as the witness has said, one or two stills, and we are not going any further than this two-still operation. Now, this will complete that line. In other words, this question will complete that line of examination.

The Court: All right. I don't see how it adds anything.

Mr. Hall: I don't think it adds very much.

A. Using the same gas oil as a charge, the capacity would be about 350 barrels per day, the gas oil being supplied at 60 degrees Fahrenheit. The temper-
4401 2111 ature at the top of the reflux condenser might be about 460 or 470 just behind the valve marked 0. The pressure distillate would be about 43 or 45 per cent by weight and about 53 gravity. The material might be put through the heat exchanger I or it might be by-passed, and if by-passed as taught in the speci-
4402 fication it would enter the bottom of the still A-1 at about 115 degrees. It would be about 120 to 125 degrees, say 120 degrees, up on line 2 leaving the heat exchanger I-1. The top of the retort A-1 would be at a higher temperature than the gas oil charge at the bottom due to the introduction of the hot gas, and that would be about 560 degrees, and the material leaving the heating coil B-5 might be at about 810

degrees, and the temperature at the top of A-5 might be about 715. There would be about 44 to 45 per cent by weight of the residue which would have a gravity of about 20 or 21, call it 21. I believe that covers it.

4405 I will state how the results would compare when using crude oil as a fresh charge and carrying out such an operation as I described with PX 844 when using gas oil as a fresh charge.

4406 The results would be comparable but, of course, different due to the different charging stock. If we take, for example a Mid-Continent crude oil of, say, 37 degrees A.P.I., the same plant would have a capacity of about 700 barrels per day of this crude oil and would top out of the crude oil the gasoline, straight run gasoline, which is in the crude oil along with the cracked gasoline. It would be a combined topping and cracking action. The yeid would, of course, be different based on the crude oil as 100 per cent. We

4406 2112 might top out of that crude oil about 32 per cent by volume of a naphtha containing the gasoline and produce residue to the extent of about 34 per cent by volume, and a cracked pressure distillate of about 30 per cent by volume, all based on the crude oil.

I have prepared calculations showing a run of this device using crude oil as a fresh feed.

(The second drawing (PX 846) corresponding to PX 844 but without the temperatures as placed on PX 844.)

4407 I will put the same data on PX 846 which I put on PX 844, considering in connection with PX 846 the use of a crude oil as a charge rather than gas oil.

4408 The charge is 37 degree A.P.I. Mid-Continent crude oil, and the plant would have a capacity about 700 barrels a day.

Again taking the feed at 60 degrees F. as it flows through the various condensers I-1 to 5, it would become preheated to about 220 degrees leaving the last exchanger I-5. It would leave the first pipe heater B-1 at a temperature of about 460, and the top temperature in A-1 about 490.

Mr. Thiess: May I ask if these temperatures that you have given at that point are the temperatures of the vapors or the liquid?

A. It would be the same.

At the top, the vapors leaving the top of the reflux condenser I-1 would be about 475. The outlet of the second pipe heater E-2 would be about 540, and
4408 2113 the outlet of the third about 610, the outlet of the fourth about 690, and the outlet of the last one
4409 about 800 to 805 degrees or thereabouts, 800 I put down.

The temperature at the top of A-2, that is of the liquid leaving A-2 or the vapors at that point, would be about 565, at the top of A-3 about 630, at the top of A-4 about 700, at the top of A-5 about 725.

I think those are the comparable temperatures that are on the other exhibit.

The charge is 100 per cent by weight and the residue about 39 per cent by weight and has a gravity of about 17 degrees A.P.I. The straight run naphtha topped out of the crude would be about 28 or 29 per cent by weight, having a gravity of about 57, and the cracked pressure distillate would be about 27 per cent by weight and have a gravity of about 53 to 54. The total gasoline would probably be about 47 to 48 per cent by weight.

4409 The Court: I am not clear as to what the witness is telling here. If these are mere calculations showing what happens when this apparatus is operated in
4410 the method disclosed by the patent then it would be admissible. If it is something else, why I can't see that it would be.

Mr. Hall: Well, we claim that is what it is and we are going to bring that out just a couple of questions, if your Honor please.

Mr. Thiess: Our contention is, of course, that this is all extraneous. He has assumed certain temperatures and pressures which he desires for this particular operation.

The Court: If he is assuming something that is outside of the disclosures of the patent as they would be understood by someone skilled in the art, then it would not be admissable.

2114 Mr. Hall: We put it only under that line that your Honor has suggested, the question that your Honor suggested yesterday, and I think in the next few questions I can bring that out and make it even clearer.

4410 Q. In the heating or cracking tubes of the setup disclosed in the Dubbs 1917 application, when used for carrying out the process disclosed therein, and the condition obtaining in these tubes in connection with the run you have given, referring particularly
4411 to PX's 884, 845 and 846, what would you say the condition would be?

A. The condition of the material in these pipe heaters would be a mixture of liquid and generated vapors with the vapors present as bubbles within the liquid.

4411 Mr. Hall: Would or would not liberation occur of the generated vapors from the non-volatilized oil, giving the word "liberation" the meaning you have previously given it in your previous testimony?

A. It would not.

Q. In describing the disclosure in the Dubbs 1917 application you referred to vapor pumps J-1, J-2, J-3 and J-4. Will you please state whether or not such instrumentalities were well known so that they might have been used in this particular situation prior to January 1, 1917?

4412 A. From my own knowledge. I have in mind a pump of the type similar to the Connersville blower or the Root blower, as it was called, which I used myself in 1918 and saw in use in gas plants prior to that time, and which would, I believe, be satisfactory for this service.

Mr. Thiess: Q. Were those gases cold or hot?

4412 2115 A. In 1918 I had occasion to use one of those on hot gas. I don't know what the temperature of the gases was but it was so hot that we had to cool the bearings and the gears by applying water cooling to them.

Q. Did you see one of these used for hot gases in 1917?

A. No, I had not seen one used for hot gases in 1917.

4413 Mr. Thiess: Q. In this pump that you say you used how hot were the gases?

A. I don't know.

Q. What pressures were they being operated at?

A. That was just a few—oh, I would say maybe a pound above atmospheric, substantially atmospheric pressure.

Q. Those pumps were not operated at the conditions shown on these drawings?

A. Not at that pressure at the time I used them in 1918.

Q. That would make quite a difference, wouldn't it?

A. Well, you would have to make a heavier shell for the pump.

Q. Then it would make a difference in the operation of the pump too?

A. Only that you would have to have a heavier shell to withstand the pressure.

4414 Q. Is it your contention that at that time there was a pump available that would pump gases and vapors at 725 at 100 pounds pressure?

A. I believe so, over a small pressure differential.

Q. Did you see one that would do that?

A. I never saw one in operation under those precise conditions, no.

Mr. Hall: Q. Well, now, as an engineer did 2116 you see pumps prior to 1917 which, as an engineer, you would have known in 1917 would have been suitable for the purpose disclosed in the Dubbs application for pumping the gases?

4415 Mr. Thiess: Just one minute.

Q. What experience had you had in 1917 and 1918 as an engineer in this line of work?

A. I was still a student in the spring of 1917.

Q. At Michigan?

A. At New York University.

Q. In what year?

A. I graduated in the spring of 1917.

Mr. Thiess: Well, if your Honor please, I don't think that he is qualified.

The Court: Tho goes to the weight, I think, of the testimony.

Mr. Hall: Now will you read the question, and read what the Court said too.

(The record was read as follows:

"Mr. Hall: Q. Well, now, as an engineer did you see pumps prior to 1917 which, as an engineer, you would have known in 1917 would have been suitable 4416 for the purpose disclosed in the Dubbs application for pumping the gases?

The Court: Well, I understand that he is asking for his personal recollection, and from his judgment as an engineer would he say that those pumps that he saw at that time were capable of doing that kind of work.")

The Witness: Yes, I think they were.

Mr. Hall: Q. Under what differential would these pumps have to work in the situation where they
2117 are employed in the Dubbs application?

The Witness: About two or three pounds pressure, just really enough to overcome the friction loss in the pipe line between the previous retort and some of the hydrostatic head in the preceding retort.

In reference to these runs which I gave, the factors which determine the operating conditions are as follows:

4417 The desire to produce a pressure distillate at least as good as that which was obtained from the Burton-Clark operation. If we fix the quality of the pressure distillate and know the pressure at which we are operating, that then determines the temperature fairly closely of the vapors leaving the reflux condenser I-1, so that by making a product, a distillate product, of a quality slightly superior to that produced prior to that time and at that time by the Burton-Clark operation, that fixes the temperature of 460 degrees which
4418 is shown for the vapors leaving the top of the reflux condenser I-1.

Then using a temperature of 740 for the temperature at which the residue is withdrawn from the
4418 2118 last retort A-5, and which temperature was a temperature in use at that time in the Burton and Burton-Clark operations for cracking gas oil to make gasoline, we then know what the temperature is at the last retort.

Now, having those conditions determined in that way the other operating conditions will follow, because the 460 temperature at the top of the reflux condenser, I-1 limits the temperature of the vapors entering the reflux condenser I-1, and so on, back through the plant.

To determine the capacity of the plant we then estimate the size of the equipment, and retorts of this approximate proportion were in use in the Burton and Burton-Clark operations in cracking processes to

produce gasoline, namely about 8 feet in diameter and 25 to 30 feet high. Using retorts 8 feet in diameter and 25 feet high and scaling the rest of the equipment from the drawings, the dimensions are determined, and that in turn fixes the capacity of the plant.

4419 The rest of the figures are those which I have computed as an engineer, representing operating conditions that would be obtained if a man operated that plant at that time, making such a pressure distillate as I have described and using a temperature of 740 degrees for the withdrawal of the residue from the last retort, and using retorts of the size in use at that time.

Mr. Thiess: If your Honor please, the answer of this witness just shows how he is expanding upon this disclosure. He started out with the premise as to what we might wish to do, and then he makes his calculations. Now there is nothing in this file wrapper that tells about the premises from which he started.

2119 The Court: While I have admitted the testimony and I think I shall not strike it, as I said last night Mr. Hall will have quite a job convincing me that it is helpful in this case. He may be able to do it in his argument but he must carry that burden.

Mr. Hall: I think I can carry that burden, if your Honor please.

Q. If you had an actual apparatus such as illustrated in Exhibit 844 and you were running it, having taken these factors which you said were the determining factors, that is the character of your pres-

4420 2120 sure distillate you proposed to produce, which corresponds to Burton-Clark, which fixed the temperature at the top of the reflux condenser I' and the temperature of the residue leaving the last retort A-5, which you say corresponded to the residue of Burton and Burton-Clark—now, having fixed these factors and using gas oil, which was used for cracking at that day, and approximately the pressure at that day and running the plant with those controls, how would the engineer determine, if he wished to, what were the temperatures at the other points you have indicated, or could that be done?

A. Do you mean by operating the plant?

Q. Yes.

A. If he operated the plant he would level the plant out on an operating condition substantially as I have computed it to be.

Q. I know, but would he need to do more than get
4421 these determining factors?

A. No, that is all. He would operate the plant holding those conditions at the desired temperatures and under this pressure, and adjust the other conditions so as to obtain these desired conditions.

If one wanted to know what the temperature was of the oil leaving the heating coil B-1, he would make no calculations at all. He would operate the plant until he would get the desired pressure distillate and the desired temperature from retort 5, and
4422 2121 then if he wanted to determine what the temperatures were in the plant he could place thermocouples or pyrometers in those locations and read them.

But not having the actual plant I had to make calculations to get these figures.

Assuming that in the Greenstreet patent the only light cracking of the vapors occurs in the digesters 24 to 30, the process disclosed in the patent would
4423 not be a practical one for the same reason that I have described before. The material that would exist as a liquid under the conditions in the digester tanks 24, 25 and so forth, if cracking temperatures existed therein, would be of such a nature that it would not be converted to dry vapors in the preheating coils 10 prior to entering the cracking coils, and coke would deposit either in the preheating coil or the cracking coil.

2122 *Cross-Examination by Mr. Theiss:*

4442 Q. On page 4195 of the record you stated that this "Dubbs patent specifically teaches that we must stay in the mixed phase region as distinguished from the vapor phase." Will you please read from the Dubbs patent where this is specifically taught by Dubbs as you have stated?

4443 A. All right. Page 1, line 53:

"B are the cracking tubes. C are the vaporizing tubes."

And page 1, line beginning 78:

"Said oil is then passed into the tubes C which are only partially filled with the oil and as the oil passes through these tubes, there is a liberation of vapors from same."

That is sufficient teaching of that to one skilled in the art at that time.

Q. Now you also state on this same page that the
4444 Dubbs patent specifically teaches "we must not enter the no man's land region by allowing the liberation of these bubbles of vapor from the liquid in the cracking tubes". Will you again please read from the Dubbs patent where that is specifically taught?

A. That same reference.

Q. Now you also stated that if you get that liberation of these bubbles of vapor from the liquid in the cracking tubes "we would then get into the condition where the vapor is the continuous phase in the cracking tubes and the residual liquid might be present as an entrained liquid." Will you again please read from the patent where that is specifically taught?

A. I don't think I said that was specifically taught in the patent, did I?

4444 2123 Q. Yes, I think you did.

A. Well, if I did, I would like to correct it.

Q. Oh, I beg your pardon. I understand the rec-
4445 ord has been corrected. Then it is not your contention that that is specifically taught in the patent?

A. No, that was a statement of a fact as I saw it, but that specifically is not mentioned in the patent.

Q. And in this same paragraph again you say: "At some percentage of vapor generation where the volume of the vapor exceeds a certain ratio to the volume of the liquid, this liberation of the vapor will take place regardless of the velocity, and that is the point which we must avoid if we are keeping within the Dubbs patent." Will you again point out were that is?

A. That is a similar statement of fact as I saw it.

Q. That is not taught in the Dubbs patent then?

A. Not that specifically, no. I think the difficulty

is, Mr. Thiess, that I intended to start a new sentence with "This liberation".

Q. I am assuming that that correction has been made, and we will make that correction, but on these
4446 last two items that I have called to your attention, you now agree that that is not specifically taught in the Dubbs patent?

A. May I make my position clear on that?

Q. All right.

A. If liberation was allowed we would then get into a condition where the vapor is the continu-
4446 2124 ous phase in the cracking tubes and the residual liquid might be present as an entrained liquid. That is not specifically stated in the Dubbs patent. That is a statement of fact.

And the next is of a similar kind. "Now somewhere, at some percentage of vapor generation where the volume of the vapor exceeds a certain ratio to the volume of the liquid, this liberation of the vapor will take place regardless of the velocity, and that is the point which we must avoid if we are keeping within the Dubbs patent." That is not specifically stated in the Dubbs patent, but that is a statement of fact as I see it.

4447 Q. You say statement of fact; you mean statement of opinion on your part?

A. Well, perhaps that is more accurate. I am stating it as a fact as I see it. Is that satisfactory?

Q. Your opinion that it is a fact?

A. All right.

4448 Assuming that vaporization means vapor generation, then an increase in pressure will tend to suppress the generation of vapors and increase the amount of liquid in the coil in proportion to the vapor.

4449 Mr. Thiess: On page 4187 of the record you were asked: "Would it be possible to have liberation of vapors, as referred to in the Dubbs patent, where the oil passed through cracking tubes, such as disclosed in the Dubbs patent, and there heated to a cracking temperature, if, we will say, 99 per cent of the liquid were converted to a vapor", and you said "Yes"

A. Yes, that is right.

4449 2125 Q. Now will you take the Dubbs patent conditions of 100 pounds pressure and a 36 Baume

gas oil charging stock, a 99 per cent vapor generation in the tubes, and state what volume of the cracking tubes would be occupied by the liquid?

A. That would be approximately 1200 to 1. That is, the volume of the vapor would be approximately
4450 1200 times the volume of the liquid. That would be about 8/100 of one per cent.

My first contact with vapor phase cracking was about 1920 or '21 when I did some work for a man in Chattanooga, Tennessee—I cannot think of his name now—he had a process where he was cracking gas oil at atmospheric pressure in the presence of steam, and operated at slightly reduced pressure, he
4451 was drawing the mixture through, his idea being to maintain safe conditions so if the tube ruptured there would be no escape of the material into the furnace. And he also applied that device to automobile engines and tractors to make them operate on gas oil. I worked with him on and off for about a year and a half or two years at that time. I think it began in the spring of 1921, it was about that time. This was experimental work. He had no commercial plant. He had pilot plants; I think he built two of them. Then I made a brief study of some of the Gyro operations. As I recall, I saw their plant at Cabin Creek, I saw both of their plants at Cabin Creek, West Virginia. The first plant went out of operation about, oh, '32 or somewhere in there, '34,
no, it was later than that, that first plant went
4451 2126 out of operation about '35 or '36. And I also
4452 saw the new plant which was built by the Alco Company. The Alco Company took me down to show me that plant, trying to sell the process to a company with which I was working at that time. So I studied that from the standpoint of my client who was investigating the cracking process to purchase, to put in operation.

That was the last time I saw those two plants. I think it was in '36. I was down there before then, a number of years prior to that. I cannot give you the year now. That was when they had the old plant in operation. I was there on those two visits about a day each time. The plants were in operation both times. The last time I was there they were still mak-

ing some changes in the operation but it was on-
4453 stream, it was operating. I think I may have been there a couple of days the first time. My recollection is the second time I was there for just one day, came in early in the morning and left in the evening.

I made an investigation of the Ramage vapor phase development plant about, I think I spent about two weeks on this plant in Detroit when he was known as the Ozonide Company. I cannot give you the date now. It was 19—I don't remember, Mr. Thiess. I know I wrote a report on it. It was done for Mr. Arnold Goss, who was contemplating putting some money into it. That was a pilot plant that Ramage had, and that work was done through the Department of Engineering Research at the University of Michigan.

Then there was a vapor phase process known as
4454 the Wade process, a man who built a number
4454 2127 of little plants around Michigan and elsewhere, and I spent some time going over one of these Wade plants which was built in Detroit toward the northern part of the city somewhere,—it has been since torn down,—and also inspected another plant that was built near Detroit of the same nature which I doubt if it ever operated. Those were supposed to be commercial plants.

That was in the last five or six years, about 1935 or thereabouts. And then, let me see, I have observed operations on a so-called, I think it was, I don't know whether it was called true vapor phase or not, but it was an operation in which the material was—the material under treatment was converted to vapor and passed through a vapor separating step and mixed with hot gases, the idea being to heat the oil vapors by means of the hot gases to carry on the conversion that way—the operation that way. That was a pilot
4455 plant at Riverside, Illinois, at the plant of the Universal Oil Products Company, about six or eight years ago.

My recollection is not certain of those dates because I have nothing to tie them to. Then about 1937 or somewhere in there, Alcorn insisted I go out and see a plant he had at Muskegon, Michigan, which was a plant operating on a somewhat similar idea; that is,

he was mixing the vapors with hot gases, the gases in this case being heated in tubes in the furnace. And I spent, oh, some hours going over that operation and also discussed it with him and some of his engineers in Ann Arbor and also in Philadelphia.

4455 2128 . Oh, there was another one, let's see, another man came from Ohio—I cannot think of his

4456 name now—had a Wade operation or something similar to it. That is the same Wade I was referring to before. The same man, had a somewhat similar operation over in Canada. It was not in Windsor, it was near there, and I advised him on that operation.

I spent about three or four days with the principal, the man from Ohio, and about one day over at the plant. I think that was my first contact with the Wade operation.

I have referred to the Ramage process and the Gyro, and the Alco. The Alco was really the Gyro. The Gyro process is the outgrowth of the Ramage process. Ramage started that work, I believe, the Great Lakes Refining Company, over in Toledo. This operation of Ramage that I had reference to was

4457 another one he was trying to promote. But the Gyro process was a development or outgrowth of the other Ramage operation.

Speaking purely from memory, the temperature used in the vapor phase Gyro operation which I saw in West Virginia was around 1050 more or less degrees Fahrenheit. It may have been higher.

4458 I was at Danciger and we made an inspection there. I do not recall now a vapor phase operation that I observed. If you have reference to the light coil that

4459 was in the plant, I don't know now whether it was vapor phase or what it was. I remember there were two cracking coils. I don't remember right now the temperature at which they operated in the light coil.

I recollect it was a thousand degrees or there-

4459 2130 abouts, but that is speaking purely from memory, I may be wrong about that.

My understanding with respect to the temperatures

4460 generally used on these vapor phase operations, such as the Gyro and the true vapor phase that I have talked about is that they are above a thousand degrees in those operations. It is possible also to

conduct vapor phase cracking operations at a temperature of 950 to 1000.

As to whether in these vapor phase operations of 950 to 1000, in my opinion it is necessary to use the kerosene type of distillate as a charging stock to pre-
4461 vent coking in the coil, the answer would be yes if it is operating at atmospheric pressure or above, let's say, without a vapor liquid separating step prior to the cracking tubes. That is a general statement.

If it is operated in connection with relatively large quantities of steam or at reduced pressure, or if there is a vapor liquid separating step prior to the cracking tubes, then of course it would not be necessary to limit it to as volatile a material as would otherwise be necessary.

Now when you say kerosene, I am assuming that
4462 you mean something which has an end point of about 550, and I know that higher boiling range materials than that can be used in these operations. Generally it is my observation that unless there is a vapor liquid separating step prior to the cracking tubes, that the distillation range of the material must be such that at least 90 per cent is distilled at about
4462 2129 625 degrees F., or possibly 630 or 635. You might be able to operate with a gas oil or clean distillate of about 32 degrees Baume gravity with a boiling range of say 800 end point, without a vapor liquid separating step and operating at atmospheric pressure or above, but that is to my mind
4463 ordinarily getting awfully close, if not into the region where the operation is not practicable; you are certainly right up to the limit, if you haven's exceeded it. In my opinion you have. In other words, the end point, I think, should be limited to about 700 or 750 degrees maximum.

4471 Q. Now, isn't it possible to operate a vapor phase process using as a charge a gas oil of about 34 gravity, having 90 per cent off by Engler Distillation at 636 F. in which the charging stock is cracked in vapor phase at approximately 1050 Fahrenheit at a coil outlet pressure of 75 pounds?

A. Understanding your question as I do, I think the answer should be "Yes". Just a moment, to see if I have missed something in this. That is about

the same kind of a gas oil we were just talking about, isn't it?

Q. Yes.

A. 75 pounds was the pressure, wasn't it?

Q. Yes.

A. Yes, I think I am all right on that. I think that would operate.

Q. Now, as I understand your testimony on the Ellis patent No. 1,396,999, you contend that he does not show a separator because his dephlegmator functions as a condenser, is that correct?

4472 2131 A. By separator you did not mean separator prior to the time the material entered the cracking tubes, did you?

Q. No, no.

A. As I recall my testimony, it was that the action in the fractionating column of Ellis insofar as the stream of material leaving the cracking coils was concerned was the opposite of what it was in Dubbs and in defendant's operation.

Q. And from that did I understand you to say that therefore Ellis did not have a separator?

A. I think not. I don't think I said that. I said what happened as material came from the cracking tubes and the digesters of Ellis into the fractionating column was solely a condensing action on those materials; while in both Dubbs and in defendant's operation there was additional vapor generation from the stream leaving the cracking tubes B or the cracking furnace, as it went into the separating vessel.

Q. Now, let us refer to defendant's operation for
4473 a moment. When the effluent from the cracking tubes leaves the valves B, isn't it all in vapor form?

A. I don't know, I doubt it very much.

Q. How much do you think there is still in liquid form after—

A. That is what I don't know.

Q. Well, supposing that it is all in vapor form, then the purpose of the topped crude is to cool and condense, is it not?

A. I don't know what the purpose of it is but there is no doubt but what the topped crude coming in
4473 2132 at about 720 degrees will cool the stream leaving the cracking furnace which is at about 930, is it?

Q. 940.

A. 940 degrees.

Q. And will condense the vapors?

A. Well, the action is this: As the material leaves the cracking furnace, according to the stipulation, there is 85 per cent vapor generation or 85 per cent by weight of the material is in the vapor state, and
4474 in the separator approximately 95 per cent of that stream is vapor and approximately 5 per cent of it is withdrawn from the bottom of the separator as part of the liquid residue. Therefore the action of that separator as it affects the stream leaving the cracking furnace, is to cause additional vapor generation rather than condensation.

Q. It is your contention that with 95 per cent by volume of vapors at the valve B, that is the pressure side of the valve B, and you don't know how much on the low pressure side, that the principal action of that effluent is vapor generation or condensation?

A. It is vapor generation and not condensation, for the reasons I have just stated.

Q. Is it your position that if you cool these vapors you don't condense them?

4474 2133 A. If you cool them at constant pressure you will increase the quantity of liquid, but the combined action of the cooling and the decrease in pressure is such that although there is 85 per cent by weight in vapor in the transfer line, there is 95 per cent approximately by weight vapor in the separator.

4475 Q. Well, doesn't that occur immediately after you pass the valve B when you reduce that pressure?

A. Well, I was not considering what happened, the infinitesimal changes or the changes that might take place in the very short distance of the pipe.

Q. We are talking now about what occurs in the vapor separator.

4475 2134 A. I was talking about the vapor separator on the one hand and the furnace on the other hand, and those two pieces of equipment are adjacent to each other.

Q. You are disregarding what occurs in the pipe in the transfer line?

A. Well, the conditions in the transfer line are stipulated.

Q. Well, the amount of vapors beyond the valve B is not stipulated, the amount of vapors in the pipe?

A. No.

Q. And didn't you say you did not know how much vapor there was beyond that expansion valve?

4476 A. At the expansion valve it is mixed with the topped crude coming from the furnace, from the low temperature furnace, and as these streams mix of course the pressure directly following the valve B is higher than it is in the vapor separator, and therefore in that mixed stream which occurs right immediately at or following this valve, there would be less vapor generation in the stream leaving the high temperature furnace than there would be in the separator.

Q. And it is your well considered opinion that there is no condensation of the effluent from the cracking furnace when that effluent meets the heated topped crude in the transfer line?

A. My recollection is that the topped crude meets the stream from the high pressure furnace at the same time—

Q. No, will you answer the question.

A. —as it passes valve B. If you will show

4476 2135 me a photograph or mechanical drawing of the connections at valves B, I can perhaps follow you a little more closely, but I told you, I was speaking of the conditions that occur in the—the conditions in the transfer line from the high temperature fur-

4477 nace and comparing them with the conditions that exist in the separator.

Q. Well, I am asking you to take the conditions as shown on these drawings.

A. Well, that is what I am doing, Mr. Thiess.

Q. You just asked me to give you a photograph of how these valves are connected?

A. You are asking me what happens in one inch of the pipe compared with what happens in the next inch of the pipe, or something of that nature.

4478 Let me put it this way, Mr. Thiess: Over the few inches of the pipe or a foot, or whatever it may be, from the valve B to the point where the crude mixes, there may be some vaporization and condensation because the conditions are, of course, changing very

rapidly there; but from the point where the crude is mixed with the material from the transfer furnace—is that what we are talking about now? Can we take that point and go on?

Q. All right, go ahead.

A. From that point on there is additional vapor generation from the stream of the high temperature furnace.

Q. And no condensation?

A. Not from that point on. Now I have got to assume a lot of things, of course, on this and I
4478 2136 am assuming equilibrium conditions insofar as the vapor and liquid are concerned, and I am
4479 talking about what happens between the point where the topped crude is mixed with material from the high temperature furnace as compared with what happens in the separator. Now if that is what you want me to talk about, I think we can make some sense out of that.

Q. Well, is it your position that all of the effluent from the cracking furnace that is in vapor form when it meets the topped crude, goes over through the vapor separator into the bubble tower?

A. You mean the same quantity?

Q. Yes.

A. Or the same material?

Q. The same quantity.

A. Well, I don't know. I am unable to determine from the information you have given me at all how much vapor and liquid there may be in this stream after it passes through the valve B and before it hits the crude line. I was not concerned with that in my previous statement. I was comparing the conditions in the separator with conditions in the transfer line of the furnace.

4480 Q. Well, if there is not any condensation of the vapors that you have in this transfer line just before it meets the topped crude, after the valve B, in the line, and if there is no condensation in the separator, then all of those vapors would go over, would they not?

4480 2137 A. They do go over. There is no condensation of the material from the high temperature furnace in the separator.

I think we have at least 95 per cent by volume vapor
4481 in this transfer line at the outlet, just beyond the valve—just before the valve. Then 85 per cent by weight of the material in the transfer line is vaporized in vapor form on the pressure side of the valve, according to the stipulation. And when we go beyond the valve, I don't know how much is vaporized.

4482 Now, with 85 per cent of vapors, if none of those vapors are condensed, talking now in quantity, all of them would go over to the bubble tower. I did not say that none of those vapors are condensed either in the separator or the line beyond the valve. I said in the separator there is no condensation of the vapors, talking quantity, no additional, no additional formation of liquid in the separator than there is in the transfer line of the stream leaving the high temperature furnace. According to the stipulation the stream leaving the high temperature furnace, 85 per cent of it by weight is in the vapor state.

4483 In the separator approximately 5 per cent by weight of the material from the high temperature furnace is withdrawn with the residue; therefore, 95 per cent by weight of the material from the high temperature furnace passes out the top of the vapor separator as vapor. Therefore, there has been an additional generation of approximately 10 per cent by weight in the stream from the high temperature furnace as it goes into and in the separator.

4483 2138 Q. Now, I would like to refer you to the Hall patent 1,175,910. I understand that it is your position that in the preheater coil 2 the oil is completely vaporized, is that correct?

A. Well, as a matter of fact I don't know, and I don't know that in any operation whether it would be all converted to vapor as it leaves those tubes
4484 or not, but the teaching of Hall is to indicate that is what he had in mind.

Q. Will you please read from the patent where he states that the oil is completely vaporized in this preheater 2?

A. I think that is what he has indicated. Page 2, beginning at line 57, maybe it will help a little bit.

"This oil is pumped by means of a pump 1 through a coil of 1 inch or 1½ inch pipe 2 located above a

furnace 3 where it is preheated by the hot products of combustion arising from the furnace 3. It is then passed through the coil of pipe 4 heated by the burners 5 to an average temperature of from 540 degrees C. to 600 degrees C."—

Which is about 1,004 to 1,112 degrees Fahrenheit—

"—according to the oil used, the temperature being determined by a pyrometer 6, the thermo-couple of
4485 which is placed in the center of the nest of tubes 4. The temperature of the gases and vapors inclosed in the tubes may be of somewhat lower temperature than that existing at the"—

and so on.

In other words, he tells us there that the material inclosed in the tubes 4 are gases and vapors. And then at the outlet end of 4 he specifically states, page 2, line 96:

4485 2139 "From coil 4 the gases and cracked oil in the state of vapor pass in the direction of the arrow"—

and so on.

Q. But he doesn't there specifically tell you that the oil is all vaporized at the outlet of the preheater 2, does he?

A. No, but he tells us that the material in tube 4 is composed of gases and vapors.

Giving the confirmation of those figures I gave on the Gyro, the statement I made this morning was that the Gyro operation was conducted at about 1050 degrees Fahrenheit at the outlet of the vapor phase cracking tubes, and I find that my observations made
4488 on the Gyro unit at Cabin Creek on December 7, 1936, showed three readings, one taken in the morning and two in the afternoon, varying between 1030 and 1040 degrees F., pressures between 58 and 60 pounds per square inch. I made the observations myself.

Mr. Thiess: Q. Have you got the Pielsticker patent 1706 of 1882 there?

A. I have got it somewhere here. I will catch it in a minute. Which one, 1707?

Q. 1706 of 1882.

A. Yes.

2140 Q. Now as I understood your testimony you
4489 stated that this Pielsticker patent gave two tem-

peratures, one 150 degrees Centigrade and 180 degrees Centigrade, is that correct?

A. No, I think I stated it indicated two temperatures, one 180 degrees Centigrade and one 200 degrees Centigrade. Those were the only two temperatures given in figures in the patent. I think that is my statement.

Q. Now I would like to call your attention to the paragraph beginning at the bottom of page 4,
4489 2141 where he discusses the production of illuminating gas from hydrocarbon oils, and in which he says, "The temperature of the coil or retort is raised sufficiently high to produce permanent gases and to cause the decomposition of the steam by the latter coming in contact with the incandescent coke inside the retort." Doesn't that give an indication of the
4490 temperature to be used by Pielsticker in the production of this light gas?

A. Yes. I so stated, that that was an operation conducted to make what we call carbureted water gas.

Q. Well, that gives an indication of temperature, does it not?

A. Yes.

Q. What would that temperature be?

A. Well, in the manufacture of carbureted water gas, temperatures around 1400 or 1500 degrees Fahrenheit are of the order. Now, in this apparatus it would be rather difficult to carry on that operation at those temperatures.

Q. But those are the temperatures that are ordinarily used in making that type of gas, are they not?

A. I think I am about right on that, within a range of 100 degrees more or less.

Q. Now, isn't it true that this paragraph beginning at the bottom of page 4 of this Pielsticker patent is the only paragraph which discusses the treatment of
4491 hydrocarbon oils and the balance of the patent is directed to chemical processes for treating other
4491 2142 materials?

A. That may be true. I am not quite sure. At least this paragraph does indicate that a mixture of hydrocarbon oils and steam would be brought into contact with incandescent coke.

Q. And the rest of the patent is directed to chemical processes for treating other materials, is it?

A. Well, he mentions fats, et cetera, all through the preceding paragraph, and that means, I should iamgine, all of the things he has mentioned at the heading of the patent, where he says, "Fats, oils, glycerine, rosins and hydrocarbons."

Q. But the only other specific reference to hydrocarbons is in this paragraph, is it not?

A. And the first paragraph. Well, the paragraph just ahead of this, he has rosin paraffin or Ozokerit. Ozokerit, I understand, is a hydrocarbon. And he mentions mineral oils, which I understand to be hydrocarbon. That is the paragraph immediately preceding that.

Q. Preceding?

4492 A. "The products of distillation whether from animal, vegetable, or mineral oils, or fats, rosin paraffin, or Ozokerit."

Q. What page are you reading from?

A. Page 4, line 48, just prior to what you read me. So in that paragraph he has mentioned specifically mineral oils and paraffin and Ozokerit.

Q. But do you agree that the greater part, except for this manufacture of this permanent gas, of

4492 2143 this patent, is directed to the treatment of other materials?

A. Yes. Most of the space is covered by mentioning fats, et cetera, linseed oils, alkaline emulsions, and things of that kind, the manufacture of soaps and acids.

4493 Q. Again referring to this patent, British patent to Pielsticker 1308 of 1891, as I understood your testimony it was your contention that since the Pielsticker patent shows a coal-fired furnace it was

4494 difficult, if not impossible, to control the rate of heating. Is that true?

A. I don't know whether I used that exact language or not, but when using hand fired coal furnaces, as shown in these drawings, and as used at that time, the control is extremely difficult and it is almost impossible to maintain constant heating conditions.

Of course, it is not my contention that from an engineering standpoint it is impossible to design a still in which oils are distilled or cracked and in which coal firing is used. A great number of the Burton shell stills were coal-fired when they were first used. It is

my contention that a man skilled in the art could
4495 design a furnace which is coal-fired and in which you could properly control the firing as of 1920, 1917, and perhaps 1916, but not at the time of these Pielsticker patents. It is not my contention that it would be difficult for a man skilled in the art to change from a coal-fired furnace to an oil fired or gas-fired furnace. It would be relatively easy.

4495 2144 I don't think there is any specific teaching of the kind of fuel in the Dubbs patent in suit for firing the furnaces, but there is a little indication in the drawings, an indication in the drawing which might indicate a gas or oil fire. There are, at least, no grates shown and the furnace construction is com-
4496 parable to that, and there is a little pipe line shown that might be taken as a gas burner. It makes no specific teaching.

Q. Now, is it your contention that the Pielsticker patent 1308 of 1891, the British patent, and of course, that would apply to the U. S. patent, which is the same, uses steam merely to force the oil out of the cracking coils to prevent carbonization in the coils?

A. Well, that is what the patent says, the British patent, at least, page 2, line 18.

In the American patent the same statement occurs, page 2, beginning line 30. There may be some other statements. In my experience in the oil cracking art I do know that it is common in a good many stills to force steam through the cracking coil at the end of the run. I don't know if it has always been done. It is not unusual.

4497 Q. Well, do you know of any in which it is not done?

A. I don't know—no, I can't say I don't know of any where there is no steam used at the end of the run. It is very common to steam out the tubes after the run for the purpose of getting the residual vapors out of the tubes so that the men can go in
4497 2145 and clean up the tubes with their turbines, but it is not used for the purpose of blowing the oil out.

It is the common practice in the shutting down of these stills to gradually cool the furnace while still pumping oil through the coil and then to charge steam

to the coils. The fires are cut first while the oil is still circulating through the furnace.

Q. Is it your position that the teaching of this use of steam in Pielsticker is contrary to this universal practice and that he charged steam to the coil while the furnace was still being operated at maximum temperature?

4498 A. I don't think he says that the furnace was operated at the maximum temperature, but he clearly says that the purpose of the steam is for emptying the oil contained in the coil at the end of the operation.

Based on current practice, it would be logical to assume, if you wanted to operate this in a natural sort of a way, that you would gradually cool and then put through your steam, rather than put in the steam while the furnace is still operating at its maximum temperature.

Q. Well, you don't think that practice would have prevailed during Pielsticker's time?

A. He says specifically the purpose of that steam. I don't need to add any more to it.

Q. Well, what he says is, in line 18, "Between the force pump C and the inlet of the coil D, a steam

4498 2146 connection H is provided for the purpose of emptying the oil contained in the coil D at the end of the operation by a steam blast." Now, does that mean that that was put in there when the operation was still operating at its maximum temperature?

4499 A. Not necessarily, no.

Q. Referring again to this Pielsticker British patent of 1891, and particularly to figure 3, isn't the purpose of the baffle plates S shown in this figure to force the vapors to the outer wall of the dome P in order to obtain condensation?

A. I don't know what the "in order" is, but the result would be that the vapors would be brought into contact with the outside, with the cylindrical surface which is the outside of the dome.

Q. Wouldn't that be for the purpose of obtaining condensation?

A. It might also be for the purpose, and I believe it is, for knocking out entrainment.

Q. Now I refer you to the patent, British patent, page 2.

A. 1891?

Q. Yes, line 45, where the patentee says:

"This dome may be provided with a number of baffle plates S, which force the vapors to come in
4500 contact with the inner surface of the dome P, where the heavier portion of them are caused to condense."

Now, doesn't that mean and doesn't he there say that they are used to cause condensation of the heavier oils?

4500 2147 A. Yes, that is right.

Q. What would be the purpose of this cup T if it were merely desired to return entrained residue to the retort I, in which the residuum is collected and from which it is removed from the connection N?

A. Do you mean what function would it have?

Q. Yes, if it was merely for the purpose of returning residuum to the retort.

4501 A. Well, the structure at the bottom of that dome, figure 3, is such that the vapors are directed against the convex plate directly above these lips, or whatever they are you have referred me to, and that is of a construction which is a rather efficient entrainment eliminator. In other words, if the parts marked T were not present the vapors would not be directed against that convex surface directly above. Those parts may have that function. They also serve—

Q. Can you find that function for that in the patent?

A. Well, the patent doesn't give them any function.

Q. It doesn't give it that function, but I will refer you to the patent where the patent says, page 2, line 40:

"The dome P may be enlarged at its base forming a sphere, and may be provided at its lower end inside with a cup-shaped projection T, into which any oil collects which may condense in the dome P and from
4502 which it may be returned into the retort I or into the supply tank A, through the pipe P'."

Now, that is the function the patent gives, is it not?

4502 2148 A. Well, he states that is what happens

and it is exactly what I was going to state as the other function of this.

Q. Well, can you point to the patent where that other function of that is referred to?

A. It is not specifically stated, but it has that function anyway.

Q. But it isn't stated in the patent?

A. No, it isn't stated in the patent.

Q. And this one is stated in the patent?

A. Well, this is a statement of fact, what happens, which is perfectly true, "into which any oil collects."

Q. As a man skilled in the art, Dr. Brown, if you were advised to put a dome on retort I, in which, in the language of the patent, page 2, line 41, the following operation was to be performed:

"The dome P may be enlarged at its base forming
4503 a sphere, and may be provided at its lower end inside with a cup-shaped projection T, into which any oil collects which may condense in the dome P and from which it may be returned into the retort I or into the supply tank A, through the pipe P'. This dome may be provided with a number of baffle plates S, which force the vapors to come in contact with the inner surface of the dome P, where the heavier portion of them are caused to condense"—

If you had that instruction, as a man skilled in the art would you imbed such a retort in the insulation surrounding the dome?

4503 2149 A. That instruction is not clear in indicating that I want to condense—

Q. Will you answer my question yes or no?

A. Yes and no.

Q. In other words, as I understand it, with that instruction you would put that dome in an insulation where you wouldn't get any cooling?

A. Yes and no.

Q. Now, if condensation is desired in this dome P wouldn't it be essential to place the dome on the retort I so that adequate cooling would be secured to obtain such condensation?

A. If I want to liquefy and there condense a large
4504 portion of the vapors going up through it I would have to water cool it and make it considerably larger than it is shown in these drawings.

Q. Supposing you don't want to condense such a
4505 large part. Couldn't you air cool it?
4507 A. I have got to figure out how much vapors are coming up through that retort per hour. I have got to find what the duty on this thing is.

Q. You had no difficulty, did you, when you did that on the Dubbs application?

A. I haven't fiured out any such operation as this on the Pielsticker.

4507 2150 Q. Then it was air cooled, was it not?

A. What was air cooled?

4508 Q. The partial condenser.

A. That is right.

Q. Couldn't you have an air cooling of the partial condenser in the Pielsticker in the same way?

A. This is no such arrangement as that, and I don't know what the through puts here are. If you want me to compute something give me the conditions and I will work them out for you to save time and bring them back Monday.

Q. I am just asking you whether you can't cool that by air? Is it your well considered opinion that you could not have a condenser on that retort which would be cooled by air and would return reflux to the tank or the inlet of the coil.

A. Well, I can do all kinds of things with it, Mr. Thiess. Were you asking me what is in the patent, or what do you want me to do with it? I am confused now. I don't know where we are. Of course you can build a great big tower and put it on top of that retort and have it air cooled and condense a lot of material. Is that what you are asking?

Q. I am asking you whether you could do it by air.

4509 A. Certainly you can cool things by air.

Q. Now I wish you would refer to page 3.

A. 1891?

Q. —of this Pielsticker patent. I want to ask you whether Pielsticker doesn't teach a separate
4509 2151 and distinct operation in each one of the first six paragraphs on that page.

A. I think not. I think the last paragraph on the previous page and the first two on page 3 all refer to substantially the same operation.

Q. What do you mean by "substantially the same operation"?

A. Well, at the bottom of page 2 he carries on a distillation with these condensers U following the retort.

At the top paragraph on page 3 he says, or instead of this arrangement he does substantially the same thing by a different arrangement in which he puts the column still W, he says, connected to the heating coil.

Then the next paragraph is still the same general arrangement but intending to produce lighter gravity oils. With the same operating conditions he then creates a back pressure on the vapors leaving the retort by various means.

Then the third paragraph, I think, is a different operation. Then he is debydrating crude oil.

In the first three paragraphs I have referred to he is distilling. That is my interpretation of those paragraphs.

Q. I asked for the first six.

A. I beg your pardon. The first two on page 3 refer to substantially the same operation as the last paragraph on page 2.

The third paragraph refers to dehydrating crude oil.

The fourth paragraph is a cracking operation referring to the production of permanent gas or very light oil.

The fifth paragraph states that the apparatus may be used for the distillation of fats and oils in the separation of fatty acids and glycerine.

The sixth paragraph says that the apparatus may also be used for the continuous production of distilled water from sea water or the concentration of brine, and so forth.

Q. Referring to the second paragraph, where Pielsticker says:

"When it is intended to produce still lighter gravity oils, a valve R may be placed between the outlet of the retort I and the condenser U which may be kept open only so far as to create a certain pressure of the gases inside the retort,"

now isn't that the usual expression used in the art to indicate cracking?

A. Not at that time and I think not today because this certain pressure is defined in the very next phrase.

Q. Now, referring to what you were coming to, you have stated that you do not believe that this second paragraph indicates a pressure which would bring about cracking because Pielsticker refers, among
4512 the methods for maintaining said pressure, to a steam blast introduced into the goose neck, Q, which is one of the three alternative methods of producing pressure. Is that correct?

A. He goes farther than that. He says such pressure may be created by means of a steam blast. In other words, the pressure that he is going to create by use of the valve R, this certain pressure is a pressure such as might be created by means of a steam blast.

4512 2153 Q. What function do you attribute to that pressure? What is that good for?

A. Well, I believe that operating as he was with these coal fires, whereby his operations could not be controlled carefully by temperature, he found he could also control the quality of his distillate by controlling the pressure.

Q. As I understood you, so far as you knew you could only get about two pounds pressure with a steam blast, is that correct?

A. Well, something of that order, two or three pounds.

Q. Assuming that you are correct in your state-
4513 ment that this second paragraph means that this pressure is utilized merely to increase the gravity of the distilled product in a continuous straight distillation, how much would a two-pound pressure affect this operation, assuming that you were taking overhead kerosene?

A. The pressure would not have very much effect,
4514 a very slight effect. He had no retort that would stand any pressure at that time.

Q. Referring to the other two methods that he speaks about, the valve, couldn't you put enough pressure on that with a valve so as to get pressure to do proper cracking to obtain kerosene?

A. You could close the valve entirely and get the same pressure on the retort that he had on his pump, if the retort would stand it.

Q. You have stated in your direct examination that you saw domes on stills used for simple distilla-

tion to reduce entrainment. Will you please tell
4514 2154 me where you saw these domes? Were they in coking stills or continuous stills, and where and when?

A. Well, I saw them on some lube oil stills.

Q. Where?

A. Near Oil City. I think I saw them in the—I am not quite sure about this, whether it was the Pennzoil plant. I think I saw them in there. I think I also saw them in the plant of the—the National Re-
4515 fining Company there near Oil City.

Q. When was this, do you remember?

A. Those at the National Refining Company were taken out somewhere around 1934 or 1935, and I saw them before they were taken out and again while they were being taken out. I know I have seen them many places. I am pretty sure they were at the National Refining Company. I saw those. I remember I did some work on lube oil distillation with that company a little later and I had occasion to note the presence of these domes. I have seen them other places but I can't tell you now.

Q. Did you inspect the inside of the domes?

A. I think I did when they were tearing out one of those stills.

Q. Were they equipped with baffle plates?

A. No. Those domes were not equipped with baffle plates. They were simply a dome on the top of the still from which the vapor line was led away.

Q. Referring again to this Pielsticker patent 1308, is it your contention that because in Pielsticker
4516 2155 the exposed heating surface of the retort is approximately equal to the heating surface of the tubes that the heat input to the retort would be approximately equal to the heat input to the tubes?

A. No, not entirely. The heat input into a tube still, of course, can be quite a bit more in B.T.U.'s per square foot than into a shell still if the oil is forced through the tubes with a good velocity and if the tubes are exposed to the heat of the furnace. But in Pielsticker he surrounded his tubes with refractory material or cast iron, and of course it is necessary to force the heat in through this cast iron or refractor, and that in a large measure would limit the heat input into

these tubes. Taking all those factors into consideration I think the heat that is put into the retort is approximately of the same magnitude as the heat that is put into the oils that pass through the tubes.

Q. There isn't any specific teaching of that in the patent, is there?

A. Oh, no.

4517 Q. Now, is the amount of heating surface the sole criterion which determines the amount of heat input to the various parts of an apparatus?

A. No. I think I have explained that, haven't I?

Q. Well, now, let me ask you, isn't it true that in the Dubbs patent disclosure the heating surface of the C tubes is much greater than the heating surface of the B tubes?

A. No, the C tubes have no heating surface. The C tubes are said to be insulated so as to prevent heat loss by radiation.

4517 2156 Q. Will you refer to the patent? Doesn't the patent show the C tubes located in a furnace which is, substantially, exactly the same as the furnace used for the B tubes?

A. From the diagram there is no difference in the enclosures of the C tubes, so far as we can tell, from the B tubes, but the patent says specifically—

Q. I am referring now to the drawing.

A. We can't look at the drawing alone.

Q. Well, you looked at the drawing alone in Pielsticker, did you not?

A. No.

4518 Q. There was no specific teaching about how much heat in the tubes and in the retort in Pielsticker, was there?

A. No, I considered the Pielsticker in its entirety, and I am doing the same thing with Dubbs.

Q. You just told me you couldn't do it from the drawings and you started to look at the drawings.

A. I told you what?

Q. The drawings of the Dubbs patent show two furnaces that are identically alike, in one of which the B tubes are located and in the other the C tubes are located, is that correct?

A. Insofar as this figures goes there is no difference, but the patent has a very specific teaching as to how you treat the C tubes.

4519 I think I stated that in the Greenstreet patent the action of the digesters 22 on the stream coming
4519 2157 from the vapor phase cracking coils was of a condensing action, in contradistinction to the action of the C tubes in the Dubbs patent and the separator in defendant's operation, in which additional vapor generation takes place. There is a separation between vapor and liquid which takes place in the digesters 22, and the liquid residue left from that separation is withdrawn from these digesters 22, from the system.

4520 Q. In your direct testimony you discussed the operating conditions given by Dr. Reiman in his testimony with respect to this Alexander patent. Will you kindly consider these same operating conditions except that you change the temperature of the vapors in the cracking tubes from 900 degrees to 1000 degrees F., and will you state how the yield would be affected from the 2 per cent gasoline figure which you were able to estimate from the partial data given by Dr. Reiman, assuming all other conditions the same?

4521 A. The conversion, instead of being about 1.9 or 2 per cent would probably be about 12 to 14 per cent.

Q. Referring again to this Alexander patent, what is the basis of your theory, given on direct, that a vapor phase operation, such as Alexander's cannot be operated without a separating step between the vaporizing coil and the cracking coil if a clean gas oil having a distillation range of from 500 to 900 degrees F. is charged to the tube?

4522 A. Well, I have explained that, I think, many times, Mr. Thiess. The basis of the idea is that such a stock will not be converted into dry vapors until after the material is heated to a cracking temperature and cracking and polymerization has started.

4522 2158 Mr. Thiess: Q. Did you ever operate such a process as Alexander shows there to get this or is this a matter of calculation on your part?

A. Both. I mean I tried to operate vapro phase
4523 operations on material not quite as heavy as that but running up to 800 and 850 degrees end point.

Q. What vapor phase operation did you try to operate?

A. We had a pilot plant, atmospheric pressure and steam—less than atmospheric pressure. We had

a material something similar to this and got into a lot of trouble with it.

Q. Where was this?

A. This was near Chattanooga, Tenn. (See p. 4589.)

Q. When?

A. About 1921 or 1922.

Q. How large was the plant?

A. The tubes were about 8 feet long. We had about eight of them, a small plant. It would be about 64 feet.

Q. What was the type of operation?

A. Introducing steam and the hydrocarbon material at one end and drawing the material through by means of suction at the other end.

Q. What happened to the material then?

A. What material?

Q. After you drew it through.

A. Well, before we put it through the pumps
4524 2159 we tried to absorb some of the material in absorption oil, condense what we could, and what did not condense went through in the absorber, and the gases coming off from the absorber went through a pump, a suction pump.

Q. Then as I understand it all you did was just put this steam and oil through a tube?

A. That is right.

Q. And heated it to what temperature?

A. Well, we used a number of temperatures.

Q. What temperatures, do you remember?

A. I think we went from about 950 up to—I think we got as high as 1200. I am not sure.

Q. Then when this material had been thus heated in the tube where did it go from there?

A. To a cooler or condenser to liquefy all that we could. We used ice, and the uncondensed material went into an oil absorber where we tried to absorb the rest of the gasoline like products out of it, and the gas that passed through the absorber then went into this suction pump.

Q. The purpose of this operation was to ascertain what, on this small pilot plant?

4525 A. This was done at the instigation of this man I knew down in Chattanooga.

Q. What was the purpose, to ascertain what?

A. Well, operating conditions and what he could use as conducting a vapor phase cracking operation under atmospheric pressure or less. That was what he had in mind.

4525 2160 Q. Well, in this tube that you put this oil through and steam you were vaporizing and cracking, both?

A. Well, it would go in as a liquid, and he thought it would vaporize and crack in these tubes.

Q. How long was the tube?

A. Eight tubes about 8 feet in length, maybe a little bit less than that.

Q. That is 64 feet all told?

A. Approximately.

Q. What was the diameter of the tubes?

A. About three-quarters of an inch, I think.

Q. Very small tubes?

A. It was a small outfit.

Q. What was the type of oil that you used there?

4526 A. We used different types. We used some fairly heavy gas oil. I don't think we had anything—at least we never determined any end points of 900. We weren't using any vacuum distillations at that time, but we had some fairly heavy gas oils.

Q. But you did not know the absolute end points on those, did you?

A. No, we only ran them on Engler distillations, and of course you can't run above—

Q. Then you don't know what the end point was?

A. Not this high. We also ran kerosene and other stocks.

Q. So that wouldn't be a definite criterion, would it?

A. What is that?

4526 2161 Q. That wouldn't be a definite criterion of what you just told me? You did not know definitely what the end points of those oils were?

A. No, but I know that we got up to 700 degrees on the ASTM distillations, and higher, without completing the distillation. I am speaking now from memory entirely. I believe we got gas oils that had between 80 per cent and 90 per cent off at, let us say,

4527 700 to 730. Of course those temperatures are not true temperatures in an Engler distillation, even at that.

Q. That is what this statement of yours is based on?

A. Not entirely, Mr. Thiess. You asked me if it was based on computations or experience and I said both.

Q. Well, that and your computations?

A. Yes. Have I answered your first question now satisfactorily?

Q. Yes. Is it your contention that Alexander did not understand that it was advantageous to use a dry vapor had he wanted to use one?

A. No. The Alexander patent clearly states that he wishes to operate with dry vapors, and he gives his reason for that, that the larger part of the heat required for the cracking operation is that required
4528 to convert the liquid oil into vapor, and therefore if he feeds dry vapors to his cracking tubes there is going to be a lower heat duty, and his heat can be more uniformly controlled. On page 2, beginning line 31, Alexander says:

4528 2162 "The vapor I use as dry as possible, that is as free as possible of droplets or suspended portions of liquid oil. This is for the reason that the heat of vaporization of oil is quite high and in the presence of liquid oil in the cracking zone heating conditions are apt to become irregular because of the absorption of heat in vaporization; I cannot get the uniform temperature conditions throughout the mass of vapor that I strive to attain. For this reason I find it best to work with a 'dry' vapor."

Q. So he appreciated that?

A. Yes. I think he realized he wanted dry vapors but I don't think he had, perhaps, the correct reason for it.

4530 Q. Will you now refer to the Biddison and Boyd patent? Now in discussing this Biddison and Boyd patent you stated, on page 4332 of the record, "Well, I believe it is clearly a vapor phase cracking". Do you remember that?

A. I think that is correct.

Q. Now I wish to refer you to some places in the specification and wish you to state whether or not the patentee in these statements agrees with you. I wish you would give me a yes or no answer, if you can.

A. I think I stated on my direct that there is some
4531 confusion and contradiction in this regard in the patent.

Q. Well, let us just take this question. On page 1, line 108, the patentee says, "In our process only a portion of the oil in the cracking zone is in the vapor state." Now, does that agree with your statement?

A. Yes.

4531 2163 Q. That it is a vapor phase operation? Does that agree with that statement?

A. Yes. I think it is predominantly a vapor phase operation, and I interpreted that expression quantitatively.

Q. Doesn't that statement say that there is liquid?

A. That is right.

Q. In the operation?

A. That is right.

Q. Then it isn't a vapor phase operation that you have been talking about, is it?

A. It is not a satisfactory vapor phase operation, no.

Q. But he there states that he has liquid in the coils, does he not?

4532 A. He says, "only a portion of the oil in the cracking zone is in the vapor state", but he has a huge quantity of gas along with the oil.

Q. Let us just forget the gas and let us take the statements of the patentee as to what he says.

A. Well, they are contradictory.

Q. All right, now let us go to the next statement, page 2, line 62, "The gas oil mixture passes out of cracking zone". Doesn't that indicate that he has liquid in the gas?

4533 A. It might and it might not.

Q. That is your well considered opinion?

4534 A. Yes.

4534 2164 Q. Now the next one, at the bottom of the first column. "From 3 the gas oil mixture passes by line 7 back to storage tank 8." Does that indicate that there is gas and oil?

A. Not necessarily.

Q. Now I refer you to page 3, line 64. "The superheated gas plus oil mixture after passing

through pressure still D", does that indicate gas and vapor, gas and oil?

A. That statement alone does not indicate that it is either all dry gas or a mixture containing particles of liquid oil.

4535 Q. Now again I refer you to page 3 at the top of the next column, line 68, "The gas oil mixture passes by line F to reservoir G". Is your answer the same as to that?

A. The same answer. Might I add a little to those answers now so my position is clear?

Q. All right.

A. The statement that you first read me, "In our process only a portion of the oil in the cracking zone is in the vapor state", definitely indicates that there is some oil present in the liquid phase. That statement, taken in connection with those that you have read me, would mean that there is some liquid present in the cracking zone.

A. I have never seen the file wrapper of the Biddison and Boyd application.

4541 Q. Now, referring to the Biddison and Boyd patent, and particularly this statement with respect to
4542 the partial pressure, the example given on the top of the first column on page 2, if other conditions
4542 2165 of pressure and the proportions of the vapor to gas, other than 100 pounds and one per cent of vapor that you used as an operating example of the process of the patent, had been used by you, would you get different conditions of liquid and vapor in this operation?

The Witness: If I understand your question correctly it is if the pressure was different and the proportion of oil and gas different, would there result a different proportion of vapor and liquid in the cracking tubes?

Mr. Thiess: Right.

The Witness: The answer is yes.

4544 Q. Dr. Brown, I wish now to go to this abandoned application file wrapper of Carbon P. Dubbs, serial number 144,979, and is it your contention that this process teaches clean circulation?

A. Yes, in the way I have defined it.

Q. Now referring to this application, where in the process does Dubbs teach that cracking is to occur?

A. He doesn't state specifically but he states that each one of the retorts from A to 1 is at a higher temperature than the previous one. Therefore cracking will occur predominantly in the last one.

Q. Can you read from the application where he teaches that cracking should occur?

4545 A. Well, an indication is given on page 3, which is the first page of the specification, line 26:

4545 2166 "to provide a method and apparatus in which a series of stills and chambers are employed and in which the hydro-carbons treated are subjected to progressively increasing temperatures;"

He mentions zones of reaction, page 2 of the specification, which is page 4, line 4:

"and the liquid are caused to contact with each other in the zones of reaction".

Q. What does that mean?

A. Well, he describes a number of reactions here,

4546 not only cracking but also rectification, distillation, and things of that kind, so I think these zones of reaction refer to all of these reactions; I do not think it means necessarily cracking any more than it means distillation or rectification.

Q. But it does mean cracking?

A. It would include cracking among the other reactions, because he describes a great many reactions that he wishes to accomplish by this process. If you have a reference, Mr. Thiess, it may save a little time. I do not think there is any specific

4547 statement. He doesn't tell you where, but he does say that the highest temperature is in A5 or the last one. I think that is about as far as he goes in telling us where cracking occurs.

He again makes somewhat the same statement on page 7, which is the typewritten page 5 of the specification, line 3:

"The oil in each succeeding still is maintained at a higher temperature than the preceding still, and as the oil passes from the first to the last still, it will have been subjected to progressively increasing temperatures until the desired amount of such

4547 2167 oil has been converted into the desired product."

Q. Now let me call your attention to page 4 of this application, beginning at the top of the page:

"advancing from those having the higher temperatures to those having the lower temperatures; to provide a method and apparatus wherein the vapors, whether the condensable vapors or the uncondensable gases, and the liquid are caused to contact with each other in the zones of reaction".

4548 That calls for cracking, doesn't it?

A. I just read that and I think the zones of reaction include cracking or any of these reactions which he stated as his object. The zones of reaction are the stills. The stills from A1 to A5.

Q. Now on page 7 at the beginning of the paragraph.

"It will be noticed that the raw material, in passing through the apparatus, has been subjected in the various stills and heating coils, to a progressively increasing temperature, while the vapors and gases given off, have been caused to percolate up through the liquid contained in the stills and are caused to mix with such liquid in the zones of reaction."

Now those are the stills again?

A. Those are the stills.

4549 Q. Cracking is supposed to take place in those stills?

A. As I told you before, Mr. Thiess, the zones of reaction means the zones in which these reactions take place which he has described and he has described a number of objects and a number of reactions.

4549 2168 Q. Well now, what reactions do you have reference to?

A. The objects, the first page, specification page 3, beginning the end of line 14:

"Other objects of the invention are: to provide a process in which the oil being treated is fractionally distilled."

Q. Would you call that a reaction?

A. Certainly.

Q. Is that a chemical reaction?

A. Not a chemical reaction, that is a physical reaction. It is a zone of reaction.

4550 "and subjected to a cracking, breaking up, and polymerization process to convert heavier hydrocarbons or like substances into lighter, and then such changed or converted oil fractionally distilled"—

He is placing a good deal of emphasis upon "fractionally" distillation, and that is what takes place in some of these earlier chambers. I call fractional distillation a reaction. There is a reaction on each contact. I don't think I usually refer to distillation as a reaction but that is one of the reactions which he has stated as the object of his invention.

Q. And cracking, you would refer to that as a reaction, would you not?

4551 A. Yes, I think both of these can be referred to as reactions but I don't think that reaction can be limited to the cracking, though, and excluding the contact in the distillation.

Q. Will you please answer my question yes or no, now? Do you ordinarily refer to distillation as a reaction?

4551 2169 A. I do at times.

Q. When you refer to distillation, do you refer to that as a reaction?

A. Yes.

Q. Always?

A. No.

Q. Most of the time?

A. Part of the time.

Q. Now when you refer to cracking, wouldn't you

4552 refer to that as reaction?

A. I do, yes.

Q. Always?

A. No.

Q. Don't you distinguish between cracking and distillation from the standpoint of reaction?

A. Not by that word, no.

Q. How do you distinguish?

A. I distinguish by—cracking is a chemical change while distillation is a physical change.

Q. In the nomenclature of the art as used by men skilled in the art, is cracking referred to ordinarily as a reaction?

A. By ordinarily, you mean what? Frequently?

Q. Most of the time?

A. Well perhaps yes.

Q. When men skilled in the art refer to cracking, don't they refer to it as a reaction?

4552 2170 A. They do refer to it as a reaction, yes.

Q. Now when men skilled in the art refer to distillation, do they refer to that as a reaction?

4553 A. Sometimes, yes. I don't know how frequently, but it is used.

Q. Now this zone of reaction is again referred to, is it not, on page 8, beginning at line 22, where the patentee says:

"Third, that the material treated is progressively subjected to increasing temperatures while maintaining any desired pressure on the vapors and gases generated, and that the resultant vapors and gases are caused to travel in the reverse direction, that is, through progressively decreasing temperatures, while caused to percolate up through the liquid so that the liquid, vapors and gases are present in the zones of reaction."

Now there, doesn't he refer to a cracking zone in those stills?

A. We have just been through that, Mr. Thiess. I think not. He refers to the reaction which takes place in those stills.

Q. And it is your position that that refers to distillation?

4554 A. It includes distillation and the other reactions which he has described as a part of the objects of the invention.

Q. Now I would like to refer you to page 4—the pages are numbered at the bottom—beginning with line 6:

"to provide a process in which the heating elements are located outside of the converting stills."

Now there, does he refer to those stills as cracking stills?

4554 2171 A. I think the phrase "converting stills" probably means the cracking stills or cracking, or "converting retorts" as it was originally.

Q. So that under those circumstances, doesn't Dubbs teach that he cracks in each one of these stills A-1 to 5?

A. No.

Q. Which one of the stills did he teach to crack?

4555 A. Certainly he cracks in the last one, and there is a conversion of some kind taking place in more than one if he is using all five, so there is some conversion taking place in the next to the last one, and we may have some cracking, we may have some polymerization and there is some chemical change taking place there.

Q. Now can you point to any place in the specification where Dubbs states that he does not crack in all the stills?

A. No, not in that language.

Q. Now, he calls these stills converting stills, doesn't he, as I have just called your attention to?

A. He does on this page, line 7, yes.

Q. Now in the Dubbs patent Dubbs said "B are the cracking tubes" and you said that made them the cracking tubes, did you not?

A. That is right.

Q. Well now here Dubbs says "converting stills"; doesn't that make each one of these stills a cracking chamber?

4556 A. It makes more than one of them a converting still, yes.

4556 2172 Q. Doesn't it make them all converting stills?

A. I do not see it that way, Mr. Thiess. The next line following what you just read me, reads: "and in which an extreme heat can be applied to the oil without necessitating superheating the reports". In other words, these converting stills are those stills in which an extreme heat is applied to the oil. Now if there is not an extreme heat applied to the oil and the oil is cold, relatively, your still would not be a converting still.

4557 Q. Is there any place in this application where Dubbs tells you to keep the stills at a low temperature, any of those stills at a low temperature?

A. Yes.

Q. Will you point out and read from the application—I don't want any explanation—where he says that?

A. Page 3, line 14:

"and a gasoline like product produced."

We must do that, mustn't we?

Q. That is your answer to my question?

A. Yes.

Q. All right. Now I would like to refer you to page 6 at the top of the page, line 2, beginning line 2:

"The vapors that are condensed in the reflux condenser I-1, are drained back into still A-1 and the surplus unvaporized oil in still A-1 overflows through

4558 overflow pipe Q-1 by means of pipe 10 into heating

coil B2, in which it is further heated up and passes from said heating coil through pipe 11 into still A-2 and the gases and vapors generated in the heating coil furnace B-2."

4558 2173 Now doesn't that indicate that cracking occurred in that coil?

A. No.

Q. Where did the gases come from?

A. There are always gases generated when you distill crude oil.

Q. Well, that would have occurred in the first still, wouldn't it?

A. Yes, but gases and vapors may still be generated in the second coil B-2 in the simple distillation of crude oil.

Q. So you think that the gases that he is referring to there are the gases that are the result of distillation?

A. I don't know what he had in mind when he said the gases but that operation to me means that there

4559 is generation of vapors in the coil B-2.

Q. You don't think that refers to cracking?

A. Not necessarily.

Q. Well, could that refer to cracking? You say not necessarily, what do you mean?

A. Well, suppose he is operating only two of these retorts—

Q. No, let us take it the way it is here, the five retorts.

A. No, he says, we can by pass any one of these retorts, any one of the furnaces.

Q. But in this operation I have just read, he starts with A-1 and goes to A-2 and so on to 5?

A. No, he only goes up to A-1, B-2 and A-2. He doesn't go any farther than that in this section that you are referring me to; it may be he had in mind at this time using simply the retort A-1 and then

4559 2174 the coil B-2, and the retort A-2.

4560 Q. Well, he goes on in that description and goes through the entire cycle, doesn't he, as he goes on down the page?

A. Well, as I read it here, Mr. Thiess, I don't see any reference to any still subsequent to A-2 in the rest of that paragraph. Now I may be wrong.

Q. Well, just read the last part of the paragraph,—

"and are subjected to a further treatment by overflowing to the next heating furnace and still by means of overflowing pipe Q-1 and this operation is followed throughout the entire apparatus."

A. Now the overflow pipe Q-1 is the overflow pipe from retort A-1.

Q. Yes, but he says to go through the entire apparatus, does he not?

A. Following through the entire apparatus, but his apparatus may consist of five retorts or less, and I don't know exactly what he had in mind in that
4561 paragraph, but to me that language does not teach cracking in the coil B-2 when we are using all five of those coils and retorts.

Q. To you it teaches distillation, does it?

A. It teaches just what it says, Mr. Thiess.

Q. I am asking you what it teaches. Does it teach distillation?

A. It teaches gases and vapors generated in the heating coil B-2.

Q. And those gases to you mean distillation, not cracking?

A. They might be either one or the other. It doesn't necessarily teach cracking.

4561 2175 Q. Now I would like to refer you to page 8, beginning at line 16:

"From the above description, it will be apparent that the raw material is first preheated by the heat units extracted in cooling the heated vapors and gases as they pass through the reflux condensers. Second, that the heat units are extracted from the oil, gases and vapors generated in the heating coils as same percolate up through the oil contained in the stills."

4562 Now, the gases and vapors that are generated in the heating coils, aren't they generated as the result of cracking?

A. They may be.

Q. Doesn't that indicate cracking to you?

A. Mr. Thiess, when you heat crude oil, particularly in a pipe still and convert part of the oil to vapor, we thereby generate vapors in the oil in the still, in that pipe still, and in crude oil there is almost always dissolved gas unless the crude is what we call a stale crude that has been stored for a long time; and that phrase means to me simply what it

says, that there are gases and vapors generated in
4563 the heating coils.

Q. Now in this operation that you have given us in which you used this gas oil, the first operation that you used, would there be gases generated as the result of distillation in that coil?

A. Probably not any uncondensable gases.

Q. As I understood you, you were expanding this application.

A. No, sir, I did not expand it, I contracted it from five to two units.

4563 2176 Q. I mean, you were putting this operation into this unit, these temperatures and pressures, as a result of the then existing commercial operations of the Burton and Clark and Burton, and Burton used gas oil as a charging stock, did he not?

A. What is the question, Burton used gas oil?

Q. Yes.

A. Yes.

Q. Then you are reading in, if you were using those processes that gas oil was to be charged here, was it not?

4564 A. I consider the operation of this process on gas oil yes.

Q. All right. Now with that gas oil operation, does the statement that I have read to you—

"The gases and vapors generated in the heating coils"—

is that the result of distillation or cracking? Page 8, beginning line 19.

A. Well, let us say that the phrase indicates cracking, that doesn't indicate cracking in all of those coils. "Gases and vapors generated in the heating coils", it may be in the last two of the five.

4565 Q. Well, reading it in connection with the other excerpts I have read to you, you mean to say that that means just the last two coils?

A. "Gases and vapors generated in the heating coils" can mean just what it says, that there is a generation of gases and vapors in the heating coils. Now if there are gases generated in the coil 5 and
4565 2177 vapors generated in coil 1, I think this language still covers that operation that I have just outlined to you.

Q. Does it cover cracking in those coils?

A. I think it indicates there is cracking in some of these coils because he is teaching a cracking operation, yes.

Q. And you would not know which one?

A. I would not know which one.

4566 Q. In how many coils and tanks does he then teach cracking?

A. At least one.

Q. Just one?

A. Yes, because we may use only one, so it teaches there must be cracking in one.

Q. If you have all five tanks in operation, does it teach cracking in one or two or three or four or five coils and tanks?

A. It certainly teaches it in the last one, and
4567 there may be some in the next to the last one.

Q. And in none of the others, that is your considered opinion?

A. It does not deny cracking in the fifth one, nor the fourth one, nor the third one, but as I interpret this it clearly teaches cracking in the last one, and if five are used it may indicate some cracking in the fourth.

Q. Let me ask you, in your opinion, does this specification teach that cracking is not to occur except in the last two coils and tanks?

A. Not necessarily, but it teaches cracking does not occur in the first one definitely.

Q. How about the remainder?

A. It depends upon how many we use and a great many other conditions.

2178 Q. I see. Suppose we use five.

A. What is the question now?

Q. The question is, does this application teach cracking in coils 1, 2, 3, 4 and 5, and tanks 1 to 5?

4568 A. No.

Q. And in how many tanks does it teach cracking, and coils?

A. It teaches cracking clearly in the last one and there is an indication that there is cracking in one prior to that.

Q. How about the coils and tanks 2 and 3?

A. That is as far as it goes, Mr. Thiess.

Q. So you don't know whether cracking is taught in coils 2 and 3, and tanks 2 and 3?

A. It doesn't teach anything about tanks 2 and 3.

4568 2179 Q. You don't know what occurs so far as cracking is concerned in those two?

A. Well, there is no teaching that cracking occurs in 2 and 3.

Q. Does the applicant specifically teach not to crack in coils and tanks 2 and 3?

A. No.

4579 Testimony Under the Rule.

Mr. Thiess: Q. Now, I would like to call your attention to page 32 of this Dubbs 1917 file wrapper (PX 848) where the statement is made:

"The applicant has found that such treatment of the oil produces the most beneficial results probably due to the fact that the passage of the oil in the small stream through the coil properly heats the same to cause the desired cracking thereof during its passage through the plurality of interconnected vertical retorts. The present invention constitutes a marked improvement over the applicant's own prior process patent 1,231,509."

4580 And then skipping to the next page:

"In reviewing the prior art attention is called to the fact that in Edwards there is no disclosure of a plurality of intereonnected retorts receiving the heated oil, so that the said oil is properly cracked in stages under the desired and proper temperatures and pressures after being received from the heating coil."

Now, having heard those statements, does that modify your opinion as to whether these retorts are used for cracking purposes?

4570 Mr. Hall: Now, if your Honor please, this witness' direct examination as to this application was based solely upon the application as filed. Now it

4570 2180 seems to me a cross examination based upon the proceedings in the Patent Office, including the statements which may have been made by the attor-

4571 neys, is not proper cross examination.

Mr. Thiess: If your Honor please, let's just state here that the statement that I am referring to was made by counsel as a statement of fact. He says "The applicant has found". Now this is not by way

of argument, this is a statement of fact, and it seems to me—

Mr. Neuman: By Dubbs.

Mr. Hall: But by Dubbs.

Mr. Thiess: It seems to me I should be entitled to refer this witness to this subject matter.

Mr. Reichmann: No, you cannot cross examine on this.

4572 The Court: Just a moment. That may very properly be evidence on your behalf but I do not think it is a basis for cross examination of this witness.

4582 The Witness: Frankly, Mr. Thiess, I cannot make much sense out of this. It doesn't mean much to me.

End of Testimony. Under the Rule.

4582 2181 This Dubbs application 144,979, was filed at the time when the Burton and Burton and Clarke
4583 stills were the commercial cracking operations that were available, and I have based some of my calculations and sizes of equipment on the Burton and Burton and Clarke results and equipment. I do not recall what the loss was in a Burton or Burton and
4584 Clarke cracking operation. Compared to modern conditions it was low. In my calculations the gas by volume is about eight per cent or by weight about eleven per cent.

Q. And isn't that very considerably higher than the loss in Burton and the Burton and Clarke operations?

4585 A. I think it is probably somewhat higher than Burton but it is still a low figure.

Q. Will you look up and see whether the Burton and Burton and Clarke loss was not somewhere in the neighborhood of two per cent by volume?

A. I think it was a little more than that. The figure I had in mind, Mr. Thiess, was about five, but I may be wrong on that.

Q. Will you look that up?

A. I will do the best I can with it.

Q. All right. Now inasmuch as you did not know the loss of the Burton, where did you get your information as to the rest of the operating conditions that you put on this sheet?

A. Well, the operating conditions and the yield are in evidence in this case and I really took those

figures as representative of the operations of Burton and Burton and Clarke.

4585 2182 Q. Did you personally make those calcula-
4586 tions that you have given me?

A. I think I made all of them except one page.

4589 2183 Mr. Thiess: Q. Dr. Brown, at page 4375, you stated that you had seen the Burton and Burton and Clark operations in 1916 and '17. Where was it that you saw those operations?

A. We made an inspection trip, as some students, to the Standard Oil of New Jersey. I also was out here at the Indiana plant on an inspection trip when I was still a student so it was prior to the spring of 1917; I think it was in that year. Subsequently
4590 I saw some again at Indiana, let me see,—I was down in the Mid-Continent field somewhere after the war.

The regular Burton or Burton and Clark stills never used a temperature of 845 in any of their cracking operations as far as I know. The temperature to the best of my knowledge, ran from about 710 to 720 up to 750 or 760, I think was the maximum.

Q. Now you have used a temperature of 845 F. at the outlet of the heating coils B-5 on Plaintiff's Exhibit 844?

A. That is right.

Q. If you had used the same temperature at the
4591 outlet of the heating coils B-5, that you used at the outlet of the heating coils B-4, namely 700 degrees, you would have obtained very different results than your calculations show, wouldn't you?

A. Oh yes.

Q. Now, likewise, if you had used a temperature of 845 on this same exhibit for still 4, the same proposition would be true?

A. The results would have been different, yes.

Q. Now, Dr. Brown, I note that in your calculations which you submitted to us you used a
4591 2184 cracking rate to gasoline and gas of 9 per cent per hour at a temperature of 770, is that correct?

4592 A. I have got 10½ per cent by weight to p.d. at 770. Or 11.8 per cent per hour volume to p.d. at 770. Now, let's see, does that answer your question?

Q. Yes. Well, as I understand, that 7.5 plus 1.5

would give us 9 per cent per hour to gasoline and p. d. at 770° is that correct?

A. That is correct, according to Humphreys & Paulus as shown on page A, PX 851.

Q. Now, what would this cracking rate be at 750?

4593 A. Well roughly, half of that.

Q. About 4½?

A. Yes, I think about that. That would be substantially correct.

Q. Now, on page 1489 of the record, you stated that at 750 F. the cracking rate would be 8 to 10 per cent per hour. Is that correct?

A. That is correct. That is the statement here.

Q. Now, it is true, is it not, that you either used too high a cracking rate for the 750 F. for the calculations referred to on page 1489 of the record with the consequent higher yield of gasoline, or you have used too low a cracking rate in the calculations you submitted in connection with Defendant's Exhibits 844 and 845. Will you please answer yes or no?

A. This may be—

Q. Will you please answer that yes or no?

A. I cannot, Mr. Thiess.

Q. All right.

4594 2185 A. The 9 per cent at 770 we were discussing was gasoline plus gas, and my recollection is not quite clear but I think this figure on 1489 was p.d. I am not sure. I have been looking here to find out.

Q. Will you look at it and see whether that is so?

A. If that was pressure distillate, that would be entirely consistent.

Q. Now, I would like to refer you to these exhibits, this Exhibit 844. Now, if you had substantial cracking in the first still A-1, under those circumstances 4595 cracked residue from still A-1 would flow through the next coil B-2, would it not?

A. If the answer has to be yes or no, yes, because my position is you cannot have a cracking temperature—

Q. Likewise, if cracking occurs in any of these stills the charge to the next coil will contain cracked residuum, will it not?

A. From the previous one, yes.

Q. Now, Doctor, whether such substantial cracking will occur in these stills, A-1 to A-5, depends primarily upon the temperature of the oil contained in the still, does it not? Will you answer that question yes or no?

A. Temperature and time.

Q. Accordingly, is it not true that the oil temperatures in these stills is critical and must be below a cracking temperature in order to insure that no residuum will be formed in the still and circulated through the system? Will you answer that yes or no.

4596 2186 A. I don't know quite what you mean by the temperature being critical. I think the temperature in the first still is certainly critical. If there is cracking in any one of these stills, the material leaving that still and going on to the next heating coil will, of course, contain the residue from the previous cracking.

Q. Under those circumstances, the temperature in the still would be critical if you wished to prevent cracked residuum from going into the next coil, is that correct?

A. I think that answer is yes. If the object is to prevent any cracked product coming from a previous still into the subsequent still, then the temperature in the previous still must be low enough so there is no substantial cracking.

Q. And that would make that temperature critical if you desired that result?

A. Well, the temperature and time factors both
4597 are to be considered, yes. The time factor would more or less be fixed by the through put, by the size of the tank and the level, and the quantity put through, and things of that kind.

Referring to this same exhibit, each one of these stills A-1 to 5 is equipped with partial condensers 1 to 5.

Q. And in each of these partial condensers the heavier vapors are condensed and returned to its particular still; that is correct, is it not?

A. There is partial condensation of the vapors.

Q. And the condensate is returned to the still, is it not?

4597 2187 A. That is right. The condensate formed in the condenser I is returned to the corresponding still marked A.

Q. And that is true of the other stills in the same manner?

4598 A. That is correct.

Q. And accordingly wouldn't a substantial portion of the heavier vapors be condensed in these partial condensers and be returned to the residuum contained in the stills?

A. The residue which was left in the still A from the vaporization also includes the condensate which has been returned from the reflux condenser I, that is true.

Q. And depending upon the design of those partial condensers, a considerable portion of the material going out of those stills as vapors, the heavier portions would be condensed in the partial condensers and that material would be returned to the still, would it not?

A. I don't know how considerable it would be off-hand, but whatever is condensed in the reflux condenser I is returned to the corresponding retort A.

Q. And that depends upon the temperature of the partial condenser, does it not?

A. Yes, and the size of it and a lot of other things.

4599 Q. And under those circumstances, isn't it also true that the temperatnre at which these partial condensers are maintained would be critical, in that this temperature would determine the amount of the heavier vapors which would be returned to the still associated with each partial condenser and the 4599 2188 portion of said vapors which might be carried over with the vapor pump to the preceding still?

A. If the condensers I were cooled with water instead of with oil as shown it would be possible to condense a greater amount of those vapors.

Q. Wouldn't that also be possible with air?

A. I think—no, it may be in the last two or three. Air would not condense as much as water would, by any means.

Q. Depending entirely upon the design.

A. Well, I am taking the partial condensers substantially as shown in these drawings. Do you want me to change them?

Q. You don't see much of the partial condenser on those drawings, do you?

4600 A. Well, the sizes given and the internal structure is indicated on I-1.

Q. You say the size is given?

A. It is by scale, yes, in proportion to the rest of the equipment.

Q. That would be diagrammatical, would it not? If you were to design a condenser you would design a condenser depending upon what you wanted to do in the partial condenser?

A. Well, I might do—if you want me to do something else, yes, we can do that of course.

Q. What do you mean?

A. I was taking the parts approximately as shown in the drawing. As far as this partial condenser is concerned, it does not give you any detail there, it is an elevation view.

4600 2189 Dubbs teaches, that the vapors from each of the partial condensers which is not condensed, is pumped by a vapor pump into the preceding still.

4601 Q. Now, how hot are the vapors which would flow through line 13 from the partial condenser I-5 to pump J-5?

A. Oh, somewhere around 710 or 720, perhaps, as they leave the top of the condenser I-5.

Q. And how much pressure differential exists between the outlet of condenser I-5 and the inlet of the still A-4?

A. Why I think about two or three pounds, possibly.

Q. Don't you think it is more than that?

A. No, the pressure in A-5 will be greater than the pressure in A-4.

Q. Why?

A. Because you have got a hydrostatic head of liquid in the line leaving the side of A-4 carrying the liquid to the heating coils B-5 and these heating coils B-5 are the same structures and give a thermo circulation, thermo syphon effect, so the pressure at the bottom of A-5 is approximately equal to the pressure

4602 at the same level in the vertical pipe leading from A-4, and in A-4 and in A-5 we have a mixture of liquid and vapor which is less dense than the liquid in the pipe leading from the side of A-4.

Q. Well, doesn't this vapor that is pumped by J-4, doesn't that have to be pumped against the liquid head in A-4?

A. Yes, that liquid and vapor head together in A-4.

Q. How much of a head is that?

4602 2190 A. Well, first of all the pressure at the top of I-5 is greater than the pressure at the top of I-4, so we have about one or two pounds, say two pounds benefit there. So the only head that has to be overcome by the pipe J-4, is the head of the mixture of liquid and vapor in A-4, which is about 22 feet high, and might be about four pounds, let's say, 4603 minus the pressure advantage between the top of I-5 and I-4, which is two pounds, so the pump J-4 would have to overcome a pressure differential of about two pounds plus the friction through the pipe. Together that is about three pounds.

Q. When you arrive at that four pound pressure for the material in A-4, what is the consistency of the material in there to give you that?

A. It is a mixture of liquid with bubbles of vapor and gas passing up through the liquid in A-4.

Q. If the material in A-4 was all liquid, how much pressure would you have to pump?

A. About two pounds more, perhaps, two or three pounds more. That would make a total perhaps of about six or seven pounds maximum then, but of course that condition does not exist.

Q. At what operating temperatures and pressures must the pump J-4 operate according to the operat- 4604 ing conditions which have been described in your exhibits 844 and 845?

A. About 700 or 720 degrees F.

Q. And what pressure?

A. You mean total pressure?

Q. Yes.

A. About 120 pounds, 125 pounds.

4604 2191 Q. And is it your position that a satisfactory vapor pump was available in 1917 that would pump vapors at these temperatures and pressure

conditions and against the pressure differential which you have mentioned?

A. I never saw a pump that would withstand 125 pounds pressure and do that other work, but I have seen pumps that would do the job as far as pressure differential goes and temperature goes that were
4605 built for atmospheric or substantially atmospheric pressure.

Q. Were those pumps designed to pump inflammable vapors and hydrocarbon gases?

A. Yes.

Q. Would such a pump be cooled?

A. You mean operating at 700 degrees?

Q. Yes.

A. My experience about 1918 indicated we had to cool the bearings when operating on hot gases with the pump we had.

Q. This was all hot gases?

A. Those were all hot gases, yes.

Q. But not operating at the temperatures and pressures that you have given?

A. I don't know what the temperature was. The shell of the pump was not built heavy enough to withstand 125 pounds. It was approximately atmospheric pressure.

4606 2192 Q. Now would the inability to provide a vapor pump capable of handling vapors at the temperature and pressures you have specified, and to operate against the pressure differential you have given, make this disclosure inoperative? Will you answer that yes or no?

A. No.

Q. Why not?

A. All we have to do would be to drop the furnaces B-1, B-2, B-3, B-4 and B-5 somewhat further below the retorts A-1, A-2, A-3, A-4 and A-5, and then the thing would operate without any pump.

Q. Would you give me that answer again?

A. All that would be necessary would be to increase the height of the retorts A-1, A-2, A-3, A-4 and A-5, in reference to the furnaces B-1, B-2, B-3, B-4 and B-5.

Q. And how would you raise them, where would you raise them?

A. It would depend upon friction loss and so on,
4607 but perhaps if we raised them,—I haven't figured it,

—but if we raised them perhaps 20 feet in the air or 25 feet in the air, the thing would operate without any pump.

Now, referring to the Dubbs application, PX 841, that application teaches, page 5, line 32, the following, with respect to the residuum which is withdrawn from the still A-5:

"The residue flowing from still A-5, or the last still of the apparatus, may be re-run through the apparatus either with or without any other treatment; or it may be mixed with a fresh supply of raw material".

Q. Now, since Dubbs teaches that the residuum
4608 from the last still may be re-run through the apparatus, either with or without any other treatment, or may be mixed with a fresh supply of raw material, should you not have shown on PXs 844 and 845
4608 2193 the residue withdrawal line from the still A-5 connected to the charging line 1 at the low pressure side of the pump K-1?

Now will you answer that yes or no.

A. No.

Q. Now this disclosure, PX 841, shows the use of parallel tubes, does it not?

A. Yes.

Q. And you used forty tubes, as I understand.

A. I think about that.

Q. And did you assume that these tubes were approximately the length of the Burton and Clark tubes?

A. I have forgotten right now, Mr. Thiess, what the length was in those. Is it stated on those sheets you have?

4609 Q. No, you used Burton and Clark as indicating, as an example which you were trying to incorporate into this operation, were you not?

A. Well not—I was relying on the Burton and Clark operation as to the knowledge that a man skilled in the art at that time would have.

Q. Well, you used the drum size, didn't you?

A. Yes, because those were available at that time.

Q. And you used parallel tubes and you used 40 tubes; what was the length of the tubes you had in mind?

A. I don't recall now, Mr. Thiess.

4609 2194 Q. Tell me why you used 40 tubes, Mr. Brown.

A. Well, I was basing it upon the heat transfer rates in the furnaces and as I recall—

Q. Burton and Clark used 40 tubes, didn't they?

A. I am not sure, I think it was about that. The
4610 number of tubes were determined by the heat duty on those furnaces and the heat balances you have. Now I am not sure what the length of those tubes would figure out. I have either forgotten or don't have it. I expected these 40 tubes to perform somewhat similarly in this operation as they did in Burton and Clark.

It was not my purpose to incorporate into this operation the Burton and Clark tubes and Burton and Clark tank with the apparatus to function as it did in the Burton and Clark still. The purpose is to operate this plant the way it would be operated by one skilled in the art at that time, using the equipment that was available to him at that time and producing a pressure distillate at least equal in quality to that
4611 of the Burton and Clark product.

Q. But you incorporated in this the Burton and Clark operation, did you not?

A. Well, I don't quite know what you mean by that.

Q. Well, in your direct testimony on page 4387, you are describing this apparatus and you say: "I will mark it on the small one. The stills used at that time were about eight feet in diameter by thirty feet long as used in the Burton operations." And
4611 2195 then I asked you about: "Did the Burton use vertical stills?" And you said, you corrected yourself and said: "Long." "About eight feet in diameter by about thirty feet long. They were placed horizontally." "Q. Then they didn't use this type of stills? A. They didn't use them in that position. They used stills of about the same dimensions and about the same construction. The Burton stills were fired. These stills are not fired, but I should presume at that time they would use stills of about the same dimensions and the same construction."

And then going on: "Because stills of that size and
46 that construction were available at that time. So we will use the stills A1, A2, A3, A4 and A5, vessels of about 8 feet in diameter by about 30 feet high, and the

coils in the various furnaces would probably be about 4-inch coils and there might be about 40 tubes in each one of those furnaces, all arranged in parallel, and the other equipment in proportion."

A. That is right.

Q. Now that is substantially the description of the Burton-Clark, is it not?

A. Of the vertical stills?

Q. Yes.

A. No, I don't think so.

Q. No, the tubes, I am talking about the tubes.

A. Well, that type of furnace was in use at that time in the Burton and Clark operations, yes.

4612 2196 Q. That is the type you used?

A. Yes, I know that was available at that time.

Q. Now do you know, Dr. Brown, what the temperature rise of the oil passing through these Burton and Clark tube banks was?

4613 A. No, I do not know; it would not be very large, circulating pretty rapidly.

Q. I have information that the temperature rise through these Burton and Clark tube banks in a normal operation was about 6 degrees; would you question that figure?

A. Well, maybe 6 or 10, something like that; it would not be very large.

Q. Now what was the temperature rise that you got through these tubes in each of the operations that you have developed?

A. B1 shows about 120; and the B2 shows about 70; B3 shows about 25; B4 shows about 60; and B5 shows about 130.

Q. Now if you had used the temperature rise through these tubes which was normal in the Burton and Clark operation, what would be the temperatures of the various stills of these operations starting with 770 on still A5?

A. Starting where?

Q. 770 on the still A5.

A. Oh, you mean you want me to go back?

Q. Yes.

A. If it were possible, and I don't think it would be, to reach that temperature with a 10 degree rise

4614 on each still, the temperature in the second A4,
4614 2197 taking the 10 degree drop through the stills—

Q. From that 845, that is the temperature you gave.

A. That is what I was going to do.

Q. That is right.

A. I thought you meant to go back to my 740.

Q. 845.

A. But in order to maintain 740 in A5, the temperature leaving B5 should be 845.

Q. All right now, come back.

A. Now if we have to limit our temperature rise to 10 degrees in B5, that would mean the temperature coming in at A4 would be 835; so then the retort A4 would be almost 100 degrees higher than retort A5 which is, of course, contrary to all teachings in the specification.

Q. It would be contrary to the—the temperature in A4 would be what?

A. Would be 835 with 740 in A5. In other words, the temperature in A4 would be 95 degrees above A5.

Q. Why would that be 95 degrees above?

4615 A. Because you are limiting me to the 10 degrees rise as it goes through A5. If it comes out of A5 at 845 and we have only 10 degrees rise in B5, it means coming into B5 at 835. And coming into B5 at 835 my temperature at the top of A5 must be 835.

4615 2198 Q. All right. No go back through the others.

A. Now, if it were 835 at the top of A4—oh, dear,—we are putting in now gases in the bottom of A4 and A5, at 720, so that would cool it some. That would probably come out of B4 at around a thousand degrees in order to maintain 845—over 900 degrees out of B4. I haven't attempted to calculate this but, let's see, it will come out of B4 at a temperature above 900 degrees because we must have 835 at the top of A4, and we are putting gas into the bottom of A4 at about 720; so those gases would then cool the oil, therefore the material coming out of B4 must be above 835 very appreciably—let's call it 920, something like that, 920 out of B4 and we take a 10 degree drop through B4 and we ought to get 910 at the top of A3.

4616 If we have 910 at the top of A3 and we put gases into

that which came off of A4 at 835, we have a drop of 20 degrees going through I4, we would come in at 815 at the bottom, and it would be 910 degrees at the top, therefore the oil coming out of B3 must be above 910. And that would probably be, let's say, a thousand out of B3. And you get yourself into an operation which, of course, is utterly impossible and the opposite of what is taught in the specification.

Q. And you would have cracking in all of the—

A. Well, you start out with the highest temperature in A1 and trying to take gasoline off at P.D., well it is just impossible.

Q. All right. Now let us go the other way,
4616 2199 let us take a temperature of 280.

A. Then we have only 10 degrees rise through each still?

Q. Each still.

A. Then it would come out of B1 at 290 and we would not get gasoline off the top, we would get—290
4617 indicated out of B1, into A1— I do not think we would ever get to a cracking temperature, Mr. Thiess.

Q. Now consequently, if you were to use a six degree rise through the tube banks of these tubes in the Dubbs application, that would radically change all of your assumptions and calculations and results in your assumed operation for this disclosure of this Dubbs process, would it not?

A. It would be impossible to operate this disclosure in this specification with a six or ten degree rise through those tubes, for the reasons that I have indicated.

Q. Oh, by the way, have you got the answers that you were to get me over the weekend?

A. You asked me about those other pages?

Q. Yes.

A. The numbers on those pages I find are put on there solely for the purpose of identifying the photostats. They bear no relation at all to the calculations or the order in which they were made. The page which you referred to, No. 28, was not made by me,
4618 was made by somebody else and is not part of
4618 2200 the calculations on which I rely for giving you this testimony. You have all of the calculations on which I have relied for my testimony regarding the

gas oil operations. You don't have a number of preliminary calculations which I made and which are not relied upon in giving my testimony. I do not think they would be of any help to you.

Q. All I wanted to know, all I asked you was whether they did appertain to this operation.

A. Yes.

Q. And they do not?

A. No. That page 28, for example, which you referred to, was a calculation made by someone else to check certain of the temperatures.

Q. And that is also true of 18, 19 and 20?

A. 18, 19 and 20, I think, referred to something entirely separate. That page 28 does have a relationship to the gas oil operations to which I have testified, but I did not make that calculation and it is not one on which I relied.

Q. Now, have you got the data on this Burton loss?

4619 A. Oh, well, the best information I can find now, the gas loss by weight would be about 5 to 6, possibly 7 per cent, and the loss by difference, that is taking the volume of the liquid recovery and subtracting from 100 would be about 3 per cent. In other words, the liquid recovery was about 97 per cent.

Q. Well, you have no knowledge of the fact that in the Burton operation their gasoline, fuel and cycle stock recovery, was substantially 100 per cent?

4619 2201 A. Well I say, the best information I can get now indicates that it was about 97 per cent.

4621 Q. Now have you got the information that we wanted on this distillation?

A. This 23 gravity material?

Q. Yes.

A. Yes, I have drawn what I call an envelope for that material, which shows the range in which the liquid and vapor may exist in contact; and my answer to your question would be, it would be impossible to vaporize that material at any temperature at pressures of 500 or 700 pounds.

Q. You mean all of it?

A. Any of it.

Q. Any of it. This is the curve you made of it?

A. Yes.

Q. Now have you got a copy of your calculations before you there?

A. On what?

Q. The copies that you gave—

A. I think I have.

Q. —of which you gave me a copy. Now referring to page A, I would like to consider for a moment
4622 some of the figures contained thereon. Now page A, that is the first page—

A. These are the capacities of the five-chamber operation on the gas oil.

4622 2202 Q. The first page of the material that you hand to me.

A. I think so.

Q. Now referring to the temperature 845 F. at the top of the page, isn't that an assumption on your part in these calculations?

A. That 845 was the temperature of the material leaving B5,—

Q. Well, I am just—

A. —which was necessary to maintain the temperature of 740 of the material in the top of—

Q. But wasn't that an assumption on your part?

A. The assumption was that I was going to withdraw the liquid from A5 at 740 degrees.

Q. And that would make under those circumstances, you would have to have 845 transfer temperature?

A. That is right.

Q. So that is an assumption, is it not.

A. 854?

4623 Q. That is not shown in the application, that is something you assumed?

A. Well, exactly what I assumed was that I was going to withdraw that liquid from A5 at a temperature of 740 because that was a cracking temperature known to be satisfactory for the production of gasoline at that time. That is the assumption. From that I got the 845.

Q. Now let us go to the next two lines, the 90 per cent there given as the per cent of transfer in the vapor state and the 86 per cent of material
4623 2203 leaving A5 as vapors, those two figures are assumptions, are they not?

A. No, they were calculations all based on this same assumption that I gave you before.

Q. But when you go back to the original assumption they become an assumption, don't they?

A. I make only two assumptions and the rest are calculated.

Q. What are the two assumptions that you made?

A. That I am to withdraw liquid from A5 at 740, and I am going to produce a pressure distillate at
4624 least equal in quality to that produced by the Burton and Clark; and I might add one more, that we are operating at about 120 or 125 pounds pressure.

4625 2204 Q. You also had to make these assumptions as to the oil going through the coils on page 46 of the photostatic sheets that are attached? Those are all assumptions, aren't they?

A. No. I might call them calculations based on the pressure, the quality of the pressure distillate and the temperature of 740 in the last still. Once we set up the basic operating conditions, that is the quality of the pressure distillate, the pressure and the temperature in the last still, all of the rest of the operators can be computed.

Q. On this sheet you give a distillation of combined feed and of reflux and residuum. Do you mean to say that at the time of this application they would have known what the combined feed was and what the reflux was?

A. That has nothing to do with it. If they operated this way they would have gotten material of about that characteristic.

Q. That is derived how? By calculations?

A. I mean the P. D. is an assumed P. D. which
4626 has a quality throughout equal to that of the Burton-Clark, so we start from that and we have to take a gas oil as a charge.

Q. And you assume the type of gas oil?

A. Yes, if we take a 33-1/2 gravity gas oil, as we did here, representative of gas oils then available, and we make the pressure distillate having substantially the qualities as set forth on your page
4626 2205 1, that is 46 of the photostat. Numbered 1 in the upper right-hand corner, page 1. The residue would then result from this operation. If we make this quality P. D. in the percentage we are making it and if the last retort has a top temperature of 740 degrees, then this residue results. We just get it.

Q. Well, where do you get the temperature to get that type of residue? That is an assumed temperature?

A. The 740?

Q. Yes.

A. Yes. 740 for the withdrawal of the liquid from
4627 the top of A-5, the quality of the pressure distillate and the yield and the pressure are the three things that we must assume or take from the art at that *time in* order to guide us in operating this plant, operating it on paper, of course.

Q. What is this "Estimate of heat of cracking" on page 3?

A. Page 3? Oh, that is an estimate of the heat required to convert the gas oil into the gas, gasoline and P. D. bottoms.

Q. Well, that is an assumption, isn't it?

A. No. That is described in text-books that we use at the university. That is common knowledge.

Q. Well, it is still an estimate, isn't it?

A. Well, I put that on myself, didn't I, the estimate?

Q. I think you did, yes.

A. I put that on just before I gave you the sheet.

Q. Is that your writing?

4627 2206 A. Yes. I put that on just before I handed you the sheet. It is the recognized method of calculating the heat of a reaction which we have
4628 used at the University of Michigan, I know, for twenty years, and this specific method is discussed in the text-books we are now using.

Q. Now, if in your calculations you had assumed a 3 per cent volume gas loss rather than a 9 per cent would that have changed all your calculations?

A. I did not assume a gas loss, Mr. Thiess, I assumed that we are going to withdraw the liquid from the last retort at 740 and make a pressure distillate of the quality given on page 1, and operate at 125 pounds, and make a yield of that pressure distillate of about, I think it is, 53 per cent by volume, or thereabouts. Then after that the rest of it comes by methods of calculation.

Q. Well, if you had had a 3 per cent rather than a 9 per cent loss that would have changed your entire calculations, would it not?

A. I could not have had—do you mean 3 per cent instead of 9 per cent?

Q. Yes.

A. It is 11 per cent here, I think it is 11 per cent by weight. If you had only a 3 per cent gas loss by
4629 weight of course it means you are doing much less cracking.

Q. And it would have changed all your calculations?

A. I didn't assume any 3 per cent gas loss
4629 2207 and base my calculations on that or assume any 10 per cent gas loss. It is the other way around.

Q. Well, your gas loss was by volume 9.9, wasn't it?

A. I don't think so. The figure that I had—I was looking at page 1 which is a later check—was 11.1 per cent by weight gas, and that is the same figure shown on page 2. Now this volume per cent gas is always obtained by adding up everything you get and subtracting from 100. It includes all errors and everything else, and that is why the volume per cent by gas will vary on different computations, different
4630 reports. But I did not assume any particular gas loss and compute back from that.

Q. I know, but what I am asking you is this, Dr. Brown: If you had had, instead of this 11.1 gas loss a 3 per cent gas loss your entire calculations would have been changed, would they not?

A. If we had only 3 per cent by weight gas loss we would have made much less pressure distillate and gasoline than even the Burton.

Q. Now let me ask you this one additional question: If you had actually used the operating conditions of Burton or Burton and Clark, then in your operations you would have gotten a 3 per cent gas loss such as Burton or Burton and Clark would have gotten and not 11 per cent, isn't that correct?

4631 A. First of all the 3 per cent gas loss that you are giving me is obtained by adding up the liquid recovery and subtracting from 100. The 11 per cent gas loss is a weight gas. The two are not com-
4631 2208 parable because quite frequently the total liquid and solid recovery from a cracking operation may be more than 100 per cent by volume. You can't

add up volume per cents and subtract from 100 and get a figure that has any significance.

The second point is that this is not a Burton operation at all and I can't operate it as Burton operated it.

Q. Or as Burton-Clark operated it?

A. As they operated theirs, because they circulated the material right around through the same heating coils and the same still, the same retort, and that is not done here at all. There is no circulation of the liquid out of any heating coil B back into the previous retort. It is an entirely different operation.

4632 Q. Where is the residuum from the last retort recycled?

A. It is withdrawn.

Q. Doesn't the patent say to return it?

A. No, it does not. It says it may be rerun but not returned.

Q. You make a distinction there?

A. Certainly. A rerun is another run period on the apparatus.

Q. Have you got a volume gas yield in your figures on your operation?

A. I think that was obtained the same way as I told you, by adding the figures up and subtracting from 100.

Q. How much was that?

4632 2209 A. On page 1 I think it is shown as 8 per cent. and I think on page 2 it is shown as 9 per cent. I think that is correct. Let me check that. That is right.

Q. Well, now, if you had operated this according to the Burton and Burton-Clark operations then you would have gotten the 3 per cent loss by volume and not the 9 per cent that you got here?

A. I think I told you that you can't operate this
4633 apparatus and this disclosure according to Burton-Clark. It is a different operation.

Q. But you based all your calculations on introducing the Burton commercial operations of Burton and Burton-Clark, did you not?

A. I based my calculations on the knowledge that a man would have in 1917 who was familiar with the operations conducted at that time, which operations

were shell stills in continuous batteries, Burton-Clark operations for cracking, and things of that kind.

Q. You used the dimensions of this Burton shell still, did you not?

A. Because I knew that those stills were available at that time.

Q. And you used the 40 parallel tubes of the Burton-Clark, did you not?

A. Not of the Burton-Clark, no.

Q. Well, you used 40 parallel tubes?

A. As shown in the specifications, yes. I
4633 2210 said there would be about 40 tubes, I think.

Q. The showing of the tubes in this Dubbs application is substantially the same as the showing of the Burton-Clark tubes in PX 505, is it not?

4634 A. Yes. They both show the slanting banks of tubes with the inlet at the lower end and the outlet at the upper end.

Q. They both rely on thermosiphon for circulating the oil through the coils?

A. They both would operate on that same basis, yes.

Mr. Thiess: I think that is all.

Mr. Hall: I have a few questions on redirect if your Honor please.

2211 *Redirect Examination by Mr. Hall.*

4634 PX 847 is a chart which I had prepared in connection with a proposed operation about which I was asked on cross-examination (R. 4528-4529). The material which I considered in connection with this chart at pressures of 500 and 700 pounds could not be vaporized at these pressures at any temperature.

4635 Referring to PX 847, I will explain why it would be impossible to vaporize that material or any part of it.

PX 847 is what is called an envelope for this material. That is, pressure is plotted upward and temperature horizontally. At atmospheric pressure, which is about 15 pounds absolute, this material would exist as a vapor at about 600 degrees Fahrenheit and
4636 would be all liquid at about 450 to 460. The properties of this material, as given to me, determine this envelope, which is shown as the bubble line up to the

critical point and then as the dew line. Between the bubble line and the dew line we may have liquid and vapor existing together.

Outside of that envelope there can exist only one phase.

Now, if we take the material at room temperature or low temperature, at 700 pounds it will be utterly impossible to convert any of that material into vapor regardless of to what temperature it is heated, and the same thing is true at 500 lbs.

A vapor is a fluid which will separate out liquid upon an increase in pressure at constant temperature and also upon a decrease in temperature at constant pressure.

4637 On my cross-examination (R. 4557) I made reference to page 3, line 14, of the Dubbs application of January 27, 1917 as a place where the application indicated one or more of the stills was to be 2212 maintained at a low temperature. There was other references, particularly page 5, line 17 of the typewritten specifications (page 6 of photostat copy) where we find the following statement:

"This arrangement permits the vapors and gases to be subjected to comparatively high and low temperatures without excessive pressure, while the 4638 vapors in their final form, as they pass to the condenser, have been scrubbed through the liquid and their temperature greatly reduced, so that as they pass from the Still A-1, to the condenser, they are at a relatively low temperature to that at which they have been subjected to in the farthest still."

This is a clear statement that the temperature of the vapors is greatly reduced as they pass back through the retort I in which they are scrubbed and that the temperature in A-I is relatively low as compared to that in A-5. Repeatedly throughout the application it is stated that the gases and vapors pass back into the retorts prior thereto, where their temperature is decreased.

On cross-examination (R. 4565) I said that if there are gases generated in the coils of the furnace B-5 and vapors generated in the coils of furnace B-1, that would still cover the operation described in the patent application as "gases and vapors generated in the heating coils."

4639 I find confirmation of this in the Dubbs application preceding the extract which Mr. Thiess read to me and I would like to explain that. As I recall, Mr. Thiess was using the phrases "gases and vapors generated in B-2" to indicate that cracking occurred in the coil B-2, and I tried to state that that phrase did not indicate to me that cracking occurred in B-2, and also what you have just read me from 4565 of the record, I find the same statement vapors generated in B-1 and gases and vapors generated in the
2213 later coils, on page 3 of the typewritten specification, which is page 5 of Mr. Thiess' copy, beginning line 26, which reads as follows:

"The oil along with the vapors generated after passing through the heating coils B-1"—

I would like to note that Dubbs himself there refers to vapors generated after passing through B-1 and does not refer to vapors and gases generated in B-1, which is exactly the statement that I have made,

4640 "—percolates up through the oil contained in the Still A-1, the Still A-1 being maintained at a predetermined temperature"—

I would like to explain that predetermined temperature is fixed by the quality of the pressure distillate which it is desired to make, as I have previously explained.

"—and the vapors that are not condensed while percolating up through the oil in retort A-1, pass up through pipe R-1, through reflux condenser I-1, through pipe 9, through pressure regulating valve 'O' and condensers 'M' and M-1 and into receiving tank 'N', from which they are delivered to suitable storage. The vapors that are condensed in the reflux condenser I-1 are drained back into retort A-1 and the surplus unvaporized oil in retort A-1 overflows through overflow pipe Q 1 by means of pipe 10 into heating coil B-2, in which it is further heated up and passes from said heating coil through pipe 11 into retort A-2"—

and this is the part that Mr. Thiess read me,

"—and the gases and vapors generated in furnace B-2, percolate up through the oil contained in retort A-2, said retort being maintained at a higher temperature than retort A-1".

4641 I interpreted this language, generated gases and

vapors in the stills B-2, B-3, B-4 and B-5 to indicate that cracking occurred certainly in B-5, and for this reason, that if cracking occurs in B-5 and A-5, these gases and vapors pass up through the reflux condenser I-5, through the line 13, back down to the
2214 lower part of A-4. Now, A-4 is at a lower temperature than A-5. Therefore gases and vapors are absorbed and dissolved in A-4. Those that are not dissolved in A-4 pass on into A-3. A-3 is at a lower temperature than A-4, and A-3 will absorb and condense the gases and vapors which are coming from A-4, and similarly in A-2 and A-1, so that the material which is withdrawn from A-1 and goes to the coil B-2 contains gases and vapors which have been dissolved and which were produced by cracking over in A-5.

As the material that leaves A-1 goes through the coil B-2 it is heated to a higher temperature, which causes the generation of gases and vapors which were absorbed in A-1. So that the statement that gases and vapors are generated in B-2 clearly does not indicate cracking in B-2 but does indicate definite
4642 cracking at some subsequent place in the apparatus, such as B-5, and Dubbs himself specifically does not refer to gases and vapors generated in B-1 but solely to vapors.

In connection with my explanation of the apparatus shown in PX 844, I mentioned the use of shell stills
4643 in continuous battery prior to January 1, 1917. At that time there was a common operation in which horizontal shell stills were used in what was called a continuous battery. The material flowed to the first shell still, which was externally fired, and a light distillate was taken off that still. Residue left in that still then flowed to a second still which was also externally fired, and heated to a higher temperature and a heavier distillate was taken off from the second
4645 shell still. The residue liquid left in the second shell still was similarly fed to a third one. These shell stills operated continuously with the material
2215 flowing into the first one continuously and the topped crude oil being removed from the last one continuously.

4643-44 I saw such stills at the time I saw the Burton apparatus prior to 1917. I have seen them a number

of times since then because they have been in operation until rather recently. That type of still is of such common form that it is described in practically all of the text books having to do with petroleum refining.

2216 FRANCIS J. HEALY, 114 Barber Street, Bradford, Pennsylvania:

Direct Examination by Mr. Blenko.

4424 I am employed by the Kendall Refining Company, Bradford, Pennsylvania in the capacity of process superintendent in charge of all processing including cracking operations. I have been with the Kendall Refining Company since April 1922. In 1924 and 1925 I was an operator on the two Dubbs units at Kendall Refining Company. My duties as operator
4425 were to run the unit and maintain conditions.

I know Mr. Lon E. Backus who was superintendent of the cracking plant in 1924 and 1925. I am familiar with the runs on the Dubbs units at the Kendall Refining Company that Mr. Backus testified about in this case on behalf of the defendant, and as an operator I had a part in these runs. From October 1924 until April 1925 there were four or five runs made.
4426 The operation was not made continuously on a charging stock employing Dubbs residuum in those periods. Such an operation was only spasmodic.

4427 The regular charging stock for the Dubbs units at the Kendall Refining Company for the period 1924 and 1925 was a 36 to 40 straw gas oil and a 30-32° A. P. I. residue produced from the Snodgrass cracking stills when available.

4428 The charging stock at that time contained a percentage of Dubbs residue in the blend which varied from 10 to 40 percent. The remainder was 36 to 40° A. P. I. straw fuel and Snodgrass residue and sometimes some "black oil." Black oil is residue from the distillation of what is called slop wax. At
2217 that time charging stock was quite scarce and we only ran one unit at a time alternately. We never used any Dubbs residuum in the charging stock

when fresh charging stock was available in sufficient quantity.

4429 The straw fuel and the Snodgrass residue were blended in an empty charging tank in proportion and then Dubbs residue was added to this mixture in the proportion required. The tank was then agitated with air in order to obtain a good mixture of the different components, and if the oil was not agitated we got stratification, especially with the Dubbs residue which was heavy.

Referring to the Dubbs cracking unit, the residue was withdrawn from the reaction chamber and taken to the fuel system which consisted of three settling tanks. From the first one the fuel was withdrawn for firing the furnaces. The residue was run into the first tank where a stratification of a heavy and a

4430 light portion took place, and this heavy material contained most of the free carbon and sediment, and this was withdrawn from the bottom of the tank and used as fuel under the furnace.

The light portion overflowed into the second tank in series wherein further separation took place. The bottom portion was also used as fuel oil and the light portion overflowed into the third tank. The accumulation of the third tank was pumped to a residue run down tank where further separation by gravity took place, the sediment going to the bottom of the tank and the upper strata pumped off and usually sold as fuel or used as fuel around the refinery. The

4431 2218 sediment had to be shovelled out and it was mixed with shavings and burned under the boiler.

There were two residue rundown tanks. We usually ran into one tank from the fuel system and allowed the other one to settle. It usually had to settle for several days before we could use it. We obtained the residue which was blended into the charging stock of these four or five runs on the Dubbs units wherein residuum was employed from the tank that had been allowed to settle, and we used a portion that was in the upper strata. To my knowledge there was not any material drawn from any of the preceding tanks that I referred to in the fuel oil system used in the charging blend.

4432 The blend was usually prepared from 24 to 48

hours previous to the run being made and then it was allowed to settle to remove any water that might be contained in it. No Dubbs residuum unblended with other stocks was ever used as a charging stock in the Dubbs units. The Dubbs residuum blended with other stocks was never reused at any time as charging stock in the same run in which such residuum was produced in the Dubbs unit. It took so long to prepare this residue, to settle it and one thing and another that the runs we made on the blends were short and we did not have time to prepare it.

2219 *Cross-Examination by Mr. Theiss.*

4433 I first went to work for the Kendall Company on April 13, 1922, and had no experience in oil cracking or oil distillation prior to that time. I worked in the
4434 yard for about six months and was then transferred to a firing position on the Snodgrass cracking still, where I remained from the fall of 1922 until the spring of 1924. At that time the Dubbs units were installed and the Snodgrass firemen were transferred to the Dubbs stills as operators. That was the first time I had anything to do with the Dubbs unit.

4435 I knew Lon Backus, who was working for Universal during the starting up period of the units. At that time Universal operators supervised the operation. We were trying to learn the operation and assisting all we could.

4436 Lon Backus later became part of the Kendall organization and was put in charge of the Dubbs plant as superintendent. I reported to him from then on, until he left the Kendall employ, along in June, 1926.

These runs, running this Dubbs residuum, were made in the fall of 1924 and the spring of 1925—about three months after the Dubbs units had been turned over to Kendall and operated by Kendall.

4437 The Dubbs units were run on this stock over a period of from October, 1924, until April, 1925.

Black oil and slop wax were bottoms from the crude oil batch distillation of a heavy wax cut that was unpressable and had to be reprocessed. These bottoms which had a gravity of approximately 32° or 33° were added as charge to the Dubbs plant as a blend

with Snodgrass residue and 36-40 straw fuel.
4438 2220 We withdrew the Dubbs residuum into a number of settling tanks in order to settle out some of the free carbon and sediment that was contained in the residue, and we could then burn the heaviest portion through a circulating fuel system. We had to keep it warm to circulate it around, other-
4439 wise the free carbon would settle out in the fuel line and plug the lines.

We had no particular difficulty getting out the settlings that we got in the tanks. We might have to clean one of these tanks and the pump suction line out every couple of months.

The Snodgrass unit referred to was a cracking unit. The material that we got from the Snodgrass unit which we ran to the Dubbs unit blended had been cracked. It was the residue from the Snodgrass cracking operation. The gravity of that was about 30-32 gravity. We never ran that Snodgrass residue
4440 in the Dubbs still without blending, because it was rather heavy.

Our normal charging stock to the Dubbs still was 36-40 straw fuel, and at times, whenever we had Snodgrass residue, we mixed that with the straw fuel and used that as the regular charging stock to the Dubbs unit.

2221 *Redirect Examination by Mr. Blenko.*

4441 The Snodgrass cracking unit was a batch operation.

The practice as to the preservation of run records that Mr. Thiess asked me about was to keep them for a period of seven or eight years and then discard them since they were of no further value to us. Up until the time of their being discarded they were usually kept in the files of the engineering department. I had some copies in my department. I had made a search for the records of those runs using residuum but I could not find any.

UNITED STATES CIRCUIT COURT OF APPEALS

For the Seventh Circuit.

I, Kenneth J. Carrick, Clerk of the United States Circuit Court of Appeals for the Seventh Circuit, do hereby certify that the foregoing printed pages contain a true copy of Volume 3 of the printed record, printed under my supervision, which, together with Volumes 1 and 2 and Volumes 4 to 7, inclusive, constitutes the record upon which the following entitled cause was heard and determined:

Cause No. 7912.

Universal Oil Products Company,
Plaintiff-Appellant,

vs.

Globe Oil & Refining Company,
Defendant-Appellee,

as the same remains upon the files and records of the United States Circuit Court of Appeals for the Seventh Circuit.

In Testimony Whereof I hereunto subscribe my name and affix the seal of said United States Circuit Court of Appeals for the Seventh Circuit, at the City of Chicago, this 18th day of August, A. D. 1943.

Kenneth J. Carrick,
(Seal) *Clerk of the United States Circuit Court of Appeals for the Seventh Circuit.*